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Genitalia of pentatomidae

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GENITALIA OF PENTATOMIDAE

BY

OSCAR WALDEMAR ROSEWALL

A Thesis Submitted to the Graduate Faculty
for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject Entomology

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GENITALIA OF PENTATOMIDAE

Since 1923 the writer has been interested in Pentatomidae and has lost no opportunity for collecting or studying any available specimens. Having spent the past fifteen years in Louisiana, where due to its semi-tropical climate, the large family of Pentatomidae is so well represented, it is no wonder that interest has been manifested in "stink-bugs". To see one's early and anticipated crop of Kentucky Wonders (Green pole-beans) "literally eaten alive by these insects" is probably sufficient motivation for interest - and incidentally to supply ample specimens for intensive study. Aside from this the classification of the family has always had its strong appeal, probably because of its meagre degree of perfection thus far attained. The status of the Pentatomidae in the Southern States is the project which has claimed much of the writer's interest for years. A complete survey and study of the question is planned and partially carried out. But circumstances have compelled the dropping of this undertaking for the time being to pursue more intensively a single phase of the subject, namely, a satisfactory basis for classification of the species.

The purpose of this paper is to show, as far as possible, that a morphological study of the genitalia of the species of Pentatomidae will aid in the differentiating of the species by giving added and constant definite characters; but, that in the

female genitalia there is a too generalized type to give specific characters.

In spite of the amount of research and study which has been applied to the classification of this family, the subject is still neither completely nor satisfactorily settled. Classifications have been determined, as definitely as possible by the study of shape of head, form of body, segmentation of beak, and other parts. There are to be found in various publications keys to the species of Pentatomidae, but for some unaccountable reason very little has been written about classification through comprehensive study of the genitalia. It is hoped that this paper will aid in settling the classification of the one hundred nine different forms studied, and, that even those unfamiliar with the group may be able to place specimens with a fair degree of certainty. In this study the writings of previous authors have been consulted, but all observations and notations were made by the present writer from a large collection of specimens, and the writer believes he has found positive definite characters that will easily determine the species and genera studied.

By no means must the impression be received that this is a new or original basis of classification. The works of Knight on Miridae, of Hungerford and Jaczewski on Corixidae, and of others on other groups of insects show how the study of genitalia

has aided in the separation of species. However the writer knows of no comprehensive previous work carried on in the study of the family Pentatomidae.

ACKNOWLEDGEMENTS

Because of the kind assistance, suggestions, and encouragement from fellow-workers the study of this project has been materially lightened. The author wishes to express his deep appreciation and sincere thanks to Dr. W. H. Wellhouse, under whose guidance this work has been carried on. Through his direction and friendly interest the work was completed.

To Dr. C. J. Drake the author expresses gratitude for identification of many specimens and for the use of specimens from his extensive private collection.

Dr. H. H. Knight has given invaluable assistance with suggestions as to technique to employ, the loan of scientific apparatus, and in making the Iowa State College collection of Pentatomidae accessible.

Dr. Dayton Stoner of the State University of Iowa, who has always kindly identified Pentatomidae during the several years of study of the family, donated many specimens.

From Professor A. A. Nichol of the University of Arizona all available Pentatomid material of his respective state was received, and his contribution aided considerably in presenting this treatise.

Messrs. G. C. Decker, G. O. Hendrickson, C. E. Smith and N. Allen furnished further specimens for study and comparison.

Mrs. Rosewall has at all times given aid and encouragement and assisted in the preparation of the paper.

REVIEW OF LITERATURE

After a comprehensive survey of the literature covering this subject, the author has reached the conclusion that the earliest definite contribution was by Burmeister (3) in 1836. He described the abdomen of the adult insect as having nine segments though he admitted that the number may vary, and noted the peculiar processes attached to the last abdominal segment.

Sharp (19) in 1890 gave the first definite account of the genitalia of a few species of Pentatomidae and was followed by Peytoureau (16) in 1895, who made a study of the genitalia of Heteroptera but did not include specific examples of Pentatomidae.

Heymons (10) a generous contributor on the subject of the genitalia of insects, in 1899, made a worthwhile contribution on the segmentation of the abdomens of several orders of insects. His "geschlechtsanhänge" are the appendages of the genital segment, and he contends that the "parameren" present may be two or four. Furthermore he considers a twelfth segment, which he calls the "telson". In this work he gives the results of his studies in comparison to Verhoeff, Wheeler, and earlier students of the embryology of the segments.

Distant (5) 1902 in the introduction to his book gives a short resume of the segmentation of the abdomen in Heteroptera and the value of the genital segment in obtaining specific characters. Later Heidemann (8) 1904 uses characters found in the genital segment to differentiate between two species of Podisus, P. cynicus Say and P. bracteatus Fitch.

Berlese (1) 1909 discusses and illustrates both the segmentation of the abdomen and the genital segment in Pentatomidae.

Foot and Strobell (6 & 7) 1914-15 in two publications have demonstrated, with definite proof, that certain characteristics of the male genital segment and its appendages give decisive marks of identification of at least two species in Pentatomidae. They have shown conclusively by rather extensive series of the two species Euschistus variolarius P.B. and E. servus Say that these two species can be distinguished constantly by the characteristics of the genital segment and its appendages.

Newell (14) 1918 and Singh-Pruthi (20) 1925 in their morphological studies on genitalia have brought together a great deal of material for the study. Newell illustrates a portion of the abdomen and the genital segment of Euschistus variolarius P.B. as the example of Pentatomidae but does not discuss the family. Both authors have considered the internal structure of the genital segment, that is, those parts back of the proc-

tiger as it rests in normal position. Unlike the author of this work Singh-Pruthi based his classification entirely upon the internal genital structures, with the exception of one external structure, the paramere.

In 1921 Jeannel (11) published an article showing intensive and diligent work on the nomenclature of the genital segments of the female Pentatomidae. His nomenclature should replace that of earlier authors especially Berlese's, with whose work he takes issue. This statement is based on the fact that Jeannel's studies include more recent morphological findings.

Crampton (4) in 1922 reviews the nomenclature of various authors and gives the terminology applicable to the genital segments of male Heteroptera. One of the genital segments figures by him is that of a Pentatomid of the genus Brochymena and labeled Brochymena 4-pustulata Fabr. However, the author does not agree with this identification.

The next two references reviewed were those of Ribaut (17) 1923 and Schröder (18) 1925. Ribaut contends that Berlese was wrong in the numbering of abdominal segments. Schröder illustrates the genus Eusthenes, labeling the proctiger as "penis" and parameres as "gonopoden".

The works of Stal (21), Macgillivray (13), Parshley (15), and Stoner (22) are an aid to nomenclature and to the proper arrangement of species in the accepted order. From the works of Stal the author received assistance in identification through

his original descriptions, and from Stoner more detailed descriptions. For terminology and nomenclature of parts Parshley and Macgillivray were referred to.

METHODS

In trying out various methods of making the structures of the genital segment more clear to the observer several points had to be considered, i.e., (1) the parts must be left in their normal position, (2) the segment must retain its shape, (3) the color should not be destroyed.

Four methods of preparing the genital segments for study were tried, namely, clearing in KOH, clearing in Diaphanol, mounting in balsam and mounting dry on white cards.

The use of 10% caustic potash gave varying results, and proved unsatisfactory because in order to clear the more heavily chitinized parts, it was necessary to leave the segment in the caustic potash solution so long that the segment would collapse upon drying, and structures in terminal chamber became displaced.

The use of Diaphanol mentioned by Kingsbury and Johannsen (12) and Singh-Pruthi (20) softened the chitin of the segment so much before depigmentation was accomplished that the segment collapsed.

The preparation of the genital segment, for mounting in Canada Balsam, resulted in too much distortion, and then, such

specimens could not be turned around as desired. Even the preparation of a paramere, for mounting in balsam, is not satisfactory because its exact position in reference to its natural position is easily lost during this process.

After due consideration the best method found was the removal of the genital segment from relaxed dry specimens by means of the hooked point of an insect pin. The careful removal was aided by the use of the binocular microscope. The genital segment was then allowed to become thoroughly dry before mounting by means of glue, on small white cards instead of points. These cards were placed on pins in the same manner as points and this manner of mounting gave an excellent white background. In nearly all cases the genital segment was attached to the card with the anterior foramen down because this character was never used in a description. In many species of Pentatomidae it is not necessary to remove entirely the segment from the abdomen of the insect, but after relaxing the specimen to simply pull the genital segment out, still attached by conjunctiva, and allow it to remain in that position. It can then be as easily studied as if it had been attached to a card.

The above method of mounting assures to all students the same aspect of the segment, no distortion, movable structures in natural position, colors as in the dried adult specimens, and no injury done to valuable specimens.

LIST OF GENERA AND SPECIES STUDIED*

Genus PLATYCARENUS Fieb. 1861

Platycarenus marginellus Stal.

Genus SCIOCORIS Fall. 1829

Sciocoris microphthalmus Flor.

Genus MECIDEA Dall. 1851

Mecidea longula Stal.

Genus BROCHYMENA Am. & Serv. 1843

Brochymena arborea Say.

Brochymena haedula Stal.

Brochymena myops Stal.

Brochymena 4-pustulata Fabr.

Brochymena affinis Van D.

Brochymena tenebrosa Walk.

Brochymena cariosa Stal.

Brochymena carolinensis Westw.

Genus PERIBALUS Muls. & Rey. 1866

Peribalus abbreviatus Uhler.

Peribalus limbolarius Stal.

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*For synonymy see Van Duzee's Catalogue of the Hemiptera of America North of Mexico (24).

Genus TRICHOPEPLA Stal 1867

Trichopepla semivittata Say.

Trichopepla atricornis Stal.

Genus RHYTIDOLOMIA Stal 1872

Rhytidolomia saucia Say.

Genus CHLOROCHROA Stal 1872

Chlorochroa uhleri Stal.

Chlorochroa congrua Uhler.

Chlorochroa ligata Say.

Chlorochroa sayi Stal.

Genus CARPOCORIS Kolen. 1846

Carpocoris remotus Horv.

Genus NORMIDEA Am. & Serv. 1843

Normidea lugens Fabr.

Normidea tetra Walk.

Normidea ypsilon Linn.
(West Indies)

Genus SOLUBEA Bergr. 1891

Solubea pugnax Fabr.

Genus EUSCHISTUS Dall. 1851

Euschistus servus Say.

Euschistus euschistoides Voll.

Euschistus conspersus Uhler.

Euschistus inflatus Van D.

Euschistus politus Uhler.

Euschistus tristigmus Say.

Euschistus tristigmus, var. pyrrhocerus H.S.

Euschistus variolarius P.B.

Euschistus ictericus Linn.

Euschistus bifibulus P.B.

Euschistus crenator Fabr.

Euschistus crassus Dall.

Genus PROXYS Spin. 1837

Proxys punctulatus P.B.

Genus COENUS Dall. 1851

Coenus delius Say.

Genus HYMENARCYS Am. & Serv. 1843

Hymenarcys aequalis Say.

Hymenarcys crassa Uhler.

Hymenarcys nervosa Say.

Genus AELIA Fabr. 1803

Aelia americana Dall.

Genus NEOTTIGLOSSA Kby. 1837

Neottiglossa undata Say.

Neottiglossa sulcifrons Stal.

Genus COSMOPEPLA Stal 1867

Cosmopepla bimaculata Thom.

Cosmopepla uhleri Montd.

Cosmopepla conspicillaris Dall.

Cosmopepla decorata Hahn.

Genus EYSARCORIS Hahn. 1834

Eysarcoris intergressus Uhler.

Genus MENECLES Stal 1867

Menecles incertus Say.

Genus PRIONOSOMA Uhl. 1863

Prionosoma podopioides Uhler.

Genus THYANTA Stal 1862

Thyanta perditor Fabr.

Thyanta custator Fabr.

Thyanta casta Stal.

Thyanta antiguensis Westw.

Thyanta rugulosa Say.

Thyanta punctiventris Van D.

Genus CHLOROCORIS Spin. 1837

Chlorocoris atrispinus Stal.

Genus LOXA Am. & Serv. 1843

Loxa florida Van D.

Genus MURGANTIA Stal 1862

Murgantia histrionica Hahn.

Genus NEZARA Am. & Serv. 1843

Nezara viridula Linn.

Nezara viridula, var. torquata Fabr.

Genus ACROSTERNUM Fieb. 1861

Acrosternum pennsylvanicum DeGeer.

Acrosternum marginatum P.B.

Acrosternum hilaris Say.

Genus BANASA Stal 1860

Banasa dimidiata Say.

Banasa subrufescens Walk.

Banasa calva Say.

Banasa sordida Uhler.

Banasa packardi Stal.

Banasa euchlora Stal.

Banasa imbuta Walk.

Genus PIEZODORUS Fieb. 1861

Piezodorus guildinii Westw.

Genus ARVELIUS Spin. 1837

Arvelius albopunctatus DeGeer.

Genus DENDROCORIS Bergr. 1891

Dendrocoris humeralis Uhler.

Dendrocoris fruticola Bergr.

Dendrocoris reticulatus Barb.

Dendrocoris contaminatus Uhler.

Genus BREPHOLOXA Van D. 1904

Brepholoxa heidemanni Van D.

Genus EDESSA Fabr. 1803

Edessa bifida Say.

Edessa meditabunda Fabr.
(West Indies)

Genus MEADORUS M. & R. 1866

Meadorus lateralis Say.

Genus ELASMOSTETHUS Fieb. 1861

Elasmostethus cruciatus Say.

Genus STIRETRUS Lap. 1832

Stiretrus anchorago Fabr.

Stiretrus anchorago, var. fimbriatus Say.

Stiretrus anchorago, var. violacens Say.

Genus ALCAEORRHYNCHUS Bergr. 1891

Alcaeorrhynchus phymatophora P.B.

Alcaeorrhynchus grandis Dall.

Genus OPLOMUS Spin. 1837

Oplomus mundus Stal.

Oplomus pulcher Dall.
(Mexico)

Genus PERILLUS Stal 1862

Perillus confluens H.S.

Perillus bioculatus Fabr.

Perillus circumcinctus Stal.

Perillus exaptus Say.

Genus EUTHYRHYNCHUS Dall. 1851

Euthyrhynchus floridanus Linn.

Genus MINEUS Stal 1867

Mineus strigipes H.S.

Genus APATETICUS Dall. 1851

Apateticus cynicus Say.

Apateticus bracteatus Fitch.

Apateticus crocatus Uhler.

Genus PODISUS H.S. 1853

Podisus maculiventris Say.

Podisus seriventris Uhler.

Podisus modestus Dall.

Podisus placidus Uhler.

Podisus sagitta Fabr.

Podisus fuscescens Dall.

Podisus mucronatus Uhler.

Podisus acutissimus Stal.

Genus ZICRONA Am. & Serv. 1843

Zicrona caerulea Linn.

MALE GENITAL SEGMENT

In systematic descriptions of entire insects the male Pentatomidae have been considered as having seven abdominal segments. From the standpoint of the morphological consideration of genitalia it is necessary to recognize more than seven segments.

For the purpose of this paper the author has accepted the view of Crampton and Schröder, that the genital segment is the ninth; though some other authors differ in this view.

When the genital segment is withdrawn from the eighth (Plate I, Fig. 6 a) it is connected by the anterior foramen to a more or less complete ring-like segment (c) by the conjunctiva (b). Segment c is then similarly connected to the eighth, and

in normal position is telescoped within it. Berlese (1) figures the genital segment as being made up of the 9th, 10th, and 11th segments. The 11th segment is the proctiger. Newell (14) designates the genital segment as a combination of the 8th and 9th, Ribaut (17) as 10th, Schröder (18) as 9th and Singh-Pruthi (20) as 9th. Because a spiracle was found on segment c in Rhaphigater nebulosa Poda., Ribaut (17) calls it the 9th segment; therefore he calls the genital segment the 10th.

Plate I, Fig. 4, illustrates the ventral aspect of the abdomen of a typical male Pentatomid (Peribalus limbolarius Stal); the segments are numbered from one to seven. These visible segments are numbered alike by practically all the systematists such as Distant and Parshley, who have made a study of the Pentatomidae. The seventh segment is therefore for systematic purposes called the genital segment; the number in the female is more.

FEMALE GENITAL SEGMENTS

Several years ago when the author was making a systematic study of the family Pentatomidae, it was apparent to him that the male genital segment showed more decided specific differences in structure than did the female genitalia. Therefore after a brief study of the female genitalia it was determined: (1) that fairly good though variable, generic characters exist among the females, and (2) that definite and constant specific characters

of real taxonomic value do not exist throughout the family. The female genitalia are of a more generalized type than is the case of the male genitalia and they tend to retain family characters. For the study of the female genitalia the author has employed Jeannel's (11) nomenclature.

In August 1926, at Baton Rouge, Louisiana, thirty-seven specimens of Euschistus servus Say were collected from a single okra plant (Abelmoschus esculentus). Many were in the act of copulating, so several males were obtained. The genitalia of the females were carefully studied, and due to the variation in shape of the 9th pleurite they could be arranged into at least four groups. Then in comparing these varieties with those of E. euschistoides Voll., E. conspersus Uhler, E. variolarius P.B., and E. tristigmus Say there was found to be considerable overlapping of characters.

The plate-like parts of the female genitalia even though originally similar do not retain their normal position when the abdomen is distended with eggs or greatly expanded by food. This makes exact comparison difficult at times.

Other examples of similarity in female genitalia are shown as follows: No differentiation between Banasa euchlora Stal and B. dimidiata Say, or between Peribalus abbreviatus Uhler and P. limbolarius Stal. In Perillus bioculatus Fabr. the sternite and the pleurite of the 9th segment vary considerably in shape. In Cosmopepla bimaculata Thom. was found a specimen in which the

structure of the genitalia was practically identical with that of C. uhleri Montd.

Therefore the author has omitted from the study any further description of the female genitalia of the Pentatomidae and has restricted his efforts to the study of the males.

DEFINITION OF TERMS USED

Genital Segment - The last definite segment, without a spiracle, which contains all the external structures pertaining to copulation. Usually considered the ninth segment.

Terminal Chamber - The cavity within the genital segment which has in practically all species a wide external opening.

Proctiger - The median more or less cylindrical-shaped structure which is prominent in all species. When the distal end is raised a round or oval-shaped external opening appears. It represents the tenth segment.

Hypandrium is the extension of the ninth sternite posteriorly.

Hypandrial Ridge is typically a transverse heavily chitinized ridge located on dorsal side of hypandrium between the distal end of proctiger and caudal edge of hypandrium. Its position varies considerably.

Parandria are the lateral expansions of the hypandrium.

Pleural Processes are the chitinous outgrowths which extend into the terminal chamber from the sides.

Parameres are the two heavily chitinized appendages typically located one near each side of the distal end of proctiger.

Anterior Foramen is the cephalad opening of the genital segment into the body cavity.

It is significant to note that all the above structures vary a great deal in size and shape, also as to position in relation to the proctiger.

Below (Fig. A) is the caudal aspect of a diagrammatically drawn genital segment which illustrates the position of most of the parts mentioned above.

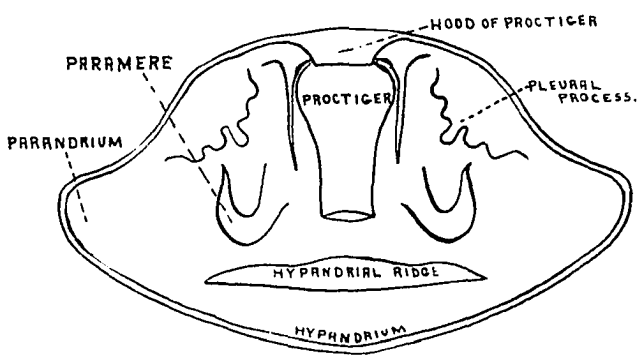


FIG. A

The following table illustrates the synonymy of terms used by students of insect genitalia in comparison to those used by the author:

Author	Crampton	Sharp	Newell	Singh-Pruthi
Genital Segment	Gonomere	Terminal Segment	8th tergite and 9th sternite	
Terminal Chamber		Terminal Chamber		Genital Chamber
Proctiger	Proctiger	Rectal Cauda	10th tergite	10th segment
Hood of Proctiger				
Hypandrium	Hypandrium	Lip		Hypandrium
Hypandrial Ridge		Inferior Process		
Parandria	Parandria			
Pleural Process	Pleural-processi			
Paramere	Styli	Lateral Pieces	Appendage of 8th somite	Paramere
Anterior Foramen				

TYPES OF MALE GENITAL SEGMENTS DEFINED

All the following types of genital segments are described as found in their normal position with respect to the eighth segment. In determining these types the genital segment is viewed from caudal aspect. Four definite types have been

developed, and with these types as a basis upon which to work, all the genital segments of the species of Pentatomidae studied have been definitely divided into four groups.

Dorsally open type, Plate I, Fig. 1.

The hypandrium (sternite) is directed dorsad, but the caudal edge does not meet the eighth sternite for its entire width. Typically the proctiger lies in a position parallel to the abdomen of the insect. Often the opening of the terminal chamber is only partially covered by the eighth tergite. The structures within the terminal chamber can be seen only from the dorsal aspect. The membranous tips of the wings, in normal position, cover the opening of the terminal chamber.

Closed type, Plate I, Fig. 2.

The hypandrium (sternite) is directed dorsad, and caudal edge meets the eighth tergite for its entire width, completely closing the terminal chamber.

Partially open type, Plate I, Fig. 3.

This type may be considered the most variable. The hypandrium (sternite) is directed dorsad, but structures within the terminal chamber can always be seen, and the proctiger is typically directed ventrad. The hypandrial ridge is usually very prominent. In most cases the segment is only partially withdrawn within the eighth segment.

Open type, Plate I, Fig. 5.

The opening to the terminal chamber is directed caudad, and

is as wide as the segment. All structures within the chamber can be seen. The caudal edge of hypandrium (sternite) is directed caudad.

OUTLINE OF GENERA

Closed Type.

1-Proctiger triangular in shape	Aelia
Proctiger not triangular in shape	2
2-Hypandrial ridge broadly concave	Eysarocoris
Hypandrial ridge not broadly concave	3
3-Hypandrium edge directed caudad	Cosmopepla
Hypandrium edge directed dorsad	Neottiglossa

Dorsally Open Type.

1-Opening of terminal chamber closed by proctiger	Piezodorus
Opening of terminal chamber not closed by proctiger	2
2-Genital segment cuneiform	Euschistus
Genital segment not cuneiform	3
3-Hypandrial posterior edge deflexed:	
a-Ventral side of segment with broad bristle bearing pits	Prionosoma
b-Ventral side of segment with small bristle bearing pits	Hymenarcys
Hypandrial posterior edge not deflexed, hypandrium with prominent median spine	Coenus

Open Type.

1-Proctiger with prominent distal reflexed spine	Meadorus
Proctiger without prominent distal reflexed spine	2

2-Both tergal and sternal caudad edges deeply emarginate ---------- Arvelius
Both tergal and sternal caudad edges not deeply emarginate ---------- 3

3-Hypandrial ridge recurved ---------- Platycarenus
Hypandrial ridge not recurved ---------- 4

4-Pleural process cup-shaped*:
A-Pleural process transversely ridged -------- Chlorocoris
B-Pleural process not distinctly tuberculate - Alcaeorrhynchus
C-Pleural process tuberculate:
a-Tubercles prominent ---------- Mineus
b-Tubercles not prominent as in preceding -- Perillus
c-Parameres biramous ---------- Apateticus
Pleural process not cup-shaped ---------- 5

5-Parameres extend almost entirely out beyond hypandrial ridge ---------- Elasmostethus

Partially Open Type.

1-Broad tergal projection of 8th segment extends caudad beyond hypandrium ---------- Zicrona
Broad tergal projection of 8th segment normal- 2

2-Entire caudal end of segment turns upward ---- Mecidea
Entire caudal end of segment does not turn upward ---------- 3

3-Parameres absent ---------- Sciocoris
Parameres present ---------- 4

4-Five processes appear in terminal chamber ---- Solubea
Less than five processes appear in terminal chamber ---------- 5

5-Paramere 3-pronged:
a-Hypandrial ridge prominent ---------- Chlorochroa
b-Hypandrial ridge not prominent ---------- Rhytidolomia
Paramere not 3-pronged ---------- 6

*Cup-shaped pleural process - This descriptive term is used rather broadly to describe the concave aspect of pleural process, the outline of concavity varying a great deal.

6-Proctiger horizontal:
a-Hypandrial edge densely covered with hairs ---------- Mormidea
b-Parameres white with distal ends brown ---------- Brepholoxa
c-Projections of lateral edges of hypandrium extend into terminal chamber ---------- Acrosternum
Proctiger not horizontal ---------- 7

7-Proctiger with V-shaped ridge dorsad ------ Peribalus
Proctiger without V-shaped ridge dorsad --- 8

8-Callouses of hypandrium cone-shaped ------- Murgantia
Callouses of hypandrium not cone-shaped --- 9

9-Parameres with recurved tip ---------- Menecles
Parameres without recurved tip ---------- 10

10-Hypandrial ridge median projection bi-lobed ---------- Loxa
Hypandrial ridge median projection not present ---------- 11

11-Hypandrial ridge marked with concentric arcs, parandria converge slightly caudad ---------- Nezara
Hypandrial ridge without concentric area -- 12

12-Hypandrial ridge fused with caudad edge of hypandrium ---------- Thyanta
Hypandrial ridge not fused with caudad edge of hypandrium ---------- 13

13-Median caudad portion of dorsal aspect of tergite transversely ridged, paramere flattened laterally ---------- Euthyrhynchus
Median caudad portion of dorsal aspect of tergite not transversely ridged ------- 14

14-Parandria flare out and tips are rounded -- Trichopepla
Parandria not flared out with tips rounded ---------- 15

15-Hood of proctiger prominent from dorsal aspect and indented, hypandrial hairs either long and prominent or dense and short ---------- Brochymena
Hood of proctiger and hypandrial hairs not as above ---------- 16

16-Pleural process cup-shaped:
A-A broad tooth-like pleural process also present ---------- Carpocoris
B-Extra tooth-like pleural process absent ------ Stiretrus
a-Hypandrial ridge sinuate from caudal aspect- Oplomus
b-Parameres (inner view) tend to be trilateral except in P. acutissimus ------- Podisus
Pleural process not cup-shaped:
a-Hypandrial emargination shallow and broad -- Edessa
b-Hypandrial emargination very broad at base, caudal parandrial edges more prominent and rounded than in Edessa ---------- Banasa
c-Hypandrial emargination deep and narrow, caudal edge projections bend cephalad -- Dendrocoris
d-Hypandrium with row of long bristle-like hairs on ventral side of caudal edge --- Proxys

MORPHOLOGY OF THE MALE GENITAL SEGMENT

The following descriptions are of the genera and species of Pentatomidae studied. The characteristics of the genera are separated from the characteristics of the species in all cases where there is more than one species included; otherwise the description is of the one representative species.

Genus PLATYCARENUS Fieb. 1861

Platycarenus marginellus Stal.

The structure and appearance of the genital segment of this species is unlike that of any other species of the Family Pentatomidae. It is of the open type and entirely drawn within the eighth segment. Its removal from the eighth segment is rather

difficult due to the irregularity of the caudal edge of the terminal chamber.

Description of genital segment: Globose in shape; dorsal aspect shows a very deep, broad, bilobed emargination and gives the appearance of having two flattened tergal expansions. Lateral aspect shows a centrally located broad indenture; sides terminate in broad peg-like processes covered with short hairs. Hypandrial ridge, for its entire length, bends posteriorly and downward. Emarginate at middle; emargination concealed, in the posterior aspect, by peg-like projections of the edge of hypandrium. Hypandrium densely covered by bristle-like hairs. Terminal chamber shallow, though at first appears deep due to directing of all projecting parts caudad. Proctiger long; distal half covered with hairs. Parameres trilateral, long, tapering, placed close to proctiger and incurved slightly over it; covered, on outer side only, with rather long bristle-like hairs.

Genus SCIOCORIS Fall. 1829

Sciocoris microphthalmus Flor.

Genital segment of partially open type. Globose in shape. Sternite turns upward and almost closes posterior view; bulbular in shape. Hypandrium concave at centre. Hypandrial ridge extends caudad above concavity of hypandrium and curves downward at sides. Pleurites expanded posteriorly, curved inward and terminate in spine. Terminal chamber small, facing almost en-

tirely the dorsal side. The short broad proctiger fills up most of basal part of chamber. Parameres absent though may be represented by two small transverse half-moon shaped ridges, one near each side distal end of proctiger. Posterior edge of tergite broadly and roundly emarginate; hood of proctiger fills up entire emargination.

Genus MECIDEA Dall. 1851

Mecidea longula Stal.

Genital segment of the open type; about one half its length extends out free of eighth segment. Rather densely covered outside and inside with straight bristly hairs. Two lateral black irregular bands, which extend longitudinally along dorsal side of abdomen, extend to posterior edge of genital segment. Parameres, in natural position, appear as two cylindrical chitinous rods, near each side of proctiger, extending from sternite to tergite. Usually are obscured on account of density of hairs extending over them. Proctiger smooth; has an angular ridge at base, which is slightly notched at angle. Hypandrium notched at centre. Hypandrial ridge indefinite. A dorsal groove runs transversely across the segment due to a slight turning up of posterior end of segment.

Genus BROCHYMENA Am. & Serv. 1843

Genital segment typically of partially open type; gradations found throughout the species toward open type as in B.

tenebrosa. A very small part of the segment free of eighth segment. Segment globose. Hypandrial hairs conspicuous. Parandria prominent in all species of genus.

B. arborea Say.

Hypandrial ridge thin, translucent, and broadly emarginate. Proctiger has a prominent mid-dorsal ridge; sides compressed for almost their entire length, and lateral edges margined. Hood of proctiger prominent and broadly angulate at apex. Inside walls of terminal chamber densely covered with short dark bristles. Paramere shaped as in Plate II, Fig. 7.

B. haedula Stal.

Hypandrial ridge thin, translucent, transversely grooved, ventrad; shallow median emargination angulate at base. Two prominent longitudinal narrow ridges on inside of hypandrium. Proctiger slightly compressed laterally; lateral margins flattened dorso-ventrally for half the distance from base; a mid-dorsal triangular groove extends from base to middle; surface entirely rugose. Hood of proctiger broadly arched at apex. Paramere shaped as in Plate II, Fig. 8. Surface rugose.

B. myops Stal.

Parandria very widely expanded. Hypandrial ridge very prominent, with broad median emargination; at lateral extremities the top of ridge roughly calloused. Proctiger enlarged

at base and concave on both sides of base. Hood of proctiger free of proctiger; follows the tergal caudad edge to pleural process, a long sharp-pointed spine. Paramere shaped as in Plate II, Fig. 9.

B. 4-pustulata Fabr.

Hypandrial ridge similar to that of B. myops, but parandria not as expansive laterad. Proctiger prominent, broad at base, and sides converge distally. Hood of proctiger broadly arched at apex; sides extend laterad free of proctiger and are explanate. Parameres shaped as in Plate II, Fig. 13.

B. affinis Van D.

Hypandrial ridge as in B. myops except that emargination is shallow and arcuate. Central ventrad aspect smooth. The parandria so expansive laterad that eighth segment is practically covered. Proctiger swollen at base, concave laterad near base, and has a mid-dorsal longitudinal ridge. Hood of proctiger thick, caudal edge sinuate, with lateral extremities merging into walls of terminal chamber. Cephalad to each paramere a deep, smooth indenture in wall of terminal chamber. Paramere shaped as in Plate II, Fig. 10.

B. tenebrosa Walk.

Hypandrial ridge prominent; the broad, shallow, median emargination bowed ventrad. It is similar to B. 4-pustulata.

Proctiger enlarged at base; sides converge slightly towards distal end. Hood of proctiger prominent; angulate at apex; lateral extremities form a ridge ventrad which widen into broad, elongate callouses. Parandria similar to those of B. 4-pustulata. Paramere shaped as in Plate II, Fig. 11.

B. cariosa Stal.

Hypandrial ridge thicker at centre than in preceding species, rugose ventrad; median emargination broad and shallow; lateral extremities merge into callouses of the parandria, which are densely covered with hairs. Parandria expanded as in B. 4-pustulata and B. tenebrosa. Sides of proctiger converge distally and below mid-lateral line, from base to near distal end; sides broadly explanate. Hood of proctiger broadly arched at apex; sides extend laterad to margin of terminal chamber; then abruptly bend ventrad. Paramere shaped as in Plate II, Fig. 15.

B. carolinensis Westw.

Hypandrial emargination deep and broad, marked with fine ridges ventrad; lateral extremities merge with caudal edge of parandria. Parandria extend further laterad than in case of B. cariosa. Has a broad blunt tooth on dorsal margin. Proctiger broadly constricted at middle, concave laterad at base; base projects dorsad as prominent broad margined ridge; margins

of ridge diverge distally and disappear. Entire surface longitudinally rugose. Hood of proctiger broadly arched; lateral extremities merge with dorsad-cephalad extremity of edge of parandria. Paramere shaped as in Plate II, Fig. 12.

Genus PERIBALUS Muls. & Rey. 1866

Genital segment of partially open type, though when wings lie flat on eighth segment, a very narrow opening is present. When in normal position segment is almost entirely drawn within eighth segment, and hypandrium turns abruptly dorsally, thereby practically closing genital chamber posteriorly. The broad thin expansion of the hypandrium, the hypandrial ridge, directed dorsally, thickened at the sides, covered with hairs, and emarginate at middle. Genital segment sparsely covered with hairs inside as well as outside. Pleural process cup-shaped, plumose, and covered with spines as shown in Plate II, Fig. 16. Proctiger with a prominent, heavily chitinized, dark-colored, V-shaped ridge on dorsal side; angle of the V proximal; dorsal distal edge dark-colored and heavily chitinized, which gives the appearance of a thick lip. Parameres flattened dorsoventrally and project out from under distal end of proctiger, though their basal attachment is normal.

P. limbolarius Stal.

Hypandrial emargination deeper than in the case of P. abbreviatus. Without peg-like pleural process. Distal extrem-

ity of paramere, caudal aspect, as in Plate II, Fig. 20.

P. abbreviatus Uhler.

With peg-like pleural process. Distal extremity of paramere, caudal aspect, as in Plate II, Fig. 21.

Genus TRICHOPEPLA Stal 1867

Genital segment of partially open type, entirely drawn within eighth abdominal segment. Caudal edge of hypandrium indefinite except where hypandrial ridge unites with parandria. Hypandrial ridge median emargination angulate at base. Ventral and lateral sides of segment sparsely covered with long hairs; same condition found within terminal chamber and includes proctiger. Genital segment globose. Parandria strongly dilated and extend beyond hypandrium. A great similarity is seen here to the external appearance of the genital segment, in normal position, of Peribalus.

T. atricornis Stal.

Hypandrial ridge emargination forming a broad obtuse angle. Pleural process a small spatulate-shaped, chitinized process extending downward into terminal chamber. Paramere: inner view of right paramere as in Plate II, Fig. 14.

T. semivittata Say.

Hypandrial ridge emargination deeper; angle at base acute, and sides sinuate. Pleural process a broad, thin chitinized

process with irregular outline extending out into terminal chamber. Paramere: inner view of right paramere as in Plate II, Fig. 19.

Genus RHYTIDOLOMIA Stal 1872

R. saucia Say.

Genital segment of partially open type with almost entire segment withdrawn within eighth one. Segment globose. Posterior aspect of segment covered with hairs. The centre-projecting posterior edge of tergite deflexed and covered with long hairs. These hairs are longer than any found on segment. Ventral view of hypandrium shows a longitudinal groove at centre; also a slight concavity on each side of groove; posterior edge thickened at centre. Hypandrial ridge thin and narrow, extending to lateral limits of thickened edge of hypandrium. Proctiger has a broad longitudinal groove on dorsal side, a prominent circular ridge about distal end, and at base two angular-shaped protuberances. Parameres flattened dorso-ventrally; sparsely covered with hairs, and have three distal prongs as shown in Plate II, Fig. 17.

Genus CHLOROCHROA Stal 1872

Genital segment of partially open type (though opening is more narrow than in Peribalus or Trichopepla and merges towards dorsally open type). Practically half of same segment extends out from eighth one. Variation in prominence of posterior edge of hypandrium characteristic for species. Free part of segment

more or less covered with sparsely placed hairs. Hypandrial ridge prominent, and in all cases emarginate at centre. Genital segment globose. Parameres tri-lobed and sparsely covered with hairs. Posterior edge of tergite suddenly bends downward with a broad truncate projection at centre, forming a hood which fits over base of proctiger; on each side of hood is formed a broad obtuse projection. Proctiger flattened dorsally, and proximal end enlarged.

C. uhleri Stal.

Posterior edge of hypandrium less prominent than in C. sayi. Paramere as in Plate II, Fig. 18. Hypandrial ridge emargination less broad but deeper than in C. sayi.

C. ligata Say.

Posterior edge of hypandrium just traceable and not as prominent as in C. uhleri. Paramere, inner aspect of right, as in Plate II, Fig. 22. Hypandrial ridge notched at centre; a broad elevation extends from ridge to posterior edge of hypandrium.

C. congrua Uhler.

Posterior edge of hypandrium traceable. Paramere as in Plate II, Fig. 24. Hypandrial ridge notch as deep at centre as in C. ligata, though broad mid-ventrad elevation, extending from base of notch to posterior edge of hypandrium, is more prominent.

C. sayi Stal.

Posterior edge of hypandrium very prominent. Paramere as in Plate II, Fig. 23. The tip of posterior lobe of paramere bends inward. Hypandrial ridge emargination at centre broad and shallow.

The four species cited above can be easily identified by the distinctive parameres.

Genus CARPOCORIS Kolen. 1846

Carpocoris remotus Horv.

Genital segment of partially open type and entirely withdrawn within eighth segment. Segment globose. Ventral side of hypandrium concave on both sides, and emargination very broad. At base of emargination hypandrium deeply and narrowly bowed downward (this portion of hypandrium may include hypandrial ridge). Lateral extremities of posterior edge of hypandrium edged with dark-colored chitinized areas. Parandria project caudad and flare out. Proctiger covered with long hairs and broadly constricted at middle. Dorsal surface is similar to dorsal surface of proctiger of genus Aelia. Cup-shaped pleural processes irregular in outline, showing above the dorsal edge another pleural process. Latter a prominent broad, tooth-like projection, directed inwardly. Parameres flattened laterally; wide groove dividing lower edge; this groove due to a prominence extending the full length of paramere near lower edge on inner side. Paramere shaped as in Plate IV, Fig. 58.

Genus MORMIDEA Am. & Serv. 1843

Genital segment of partially open type; about one half its length extending out from eighth segment. Hypandrial edge densely covered with hairs. The dorsal part of proctiger can be seen lying horizontal in position.

M. lugens Fabr.

Hypandrium acutely emarginate, and hind margin deflexed. Outer edge of terminal chamber broadly rounded and yellow in color. Inside of chamber dark-colored and lined with hairs. Hypandrial ridge prominent; broad shallow emargination as wide as distal end of proctiger. Extremities slightly thickened. Proctiger has a large deep concavity; concavity sparsely covered with hairs in middle of dorsal side, and includes about half the length. Hood of proctiger broadly rounded at apex with a very slight emargination. Parameres very small and blunt.

M. tetra Walk.

Hypandrium sinuate and slightly deflexed on hind margin. Sides of hypandrium turn up abruptly; lateral callouses prominent, broad, black in color, and project upward as blunt processes. Just above the callouses, one on each side, are two prominent rounded processes light in color. The outer edge of terminal chamber interrupted by a fissure on each side above rounded processes. On each side of hood of proctiger just above

the parameres is a group of dark-colored, irregular-shaped pleural processes. Distal two-thirds of proctiger shiny black, while distal end appears to be turned up due to a broad concavity on dorsal side. Proctiger narrows distally for about one-half its length. Hood of proctiger broadly rounded; emarginate at apex. Parameres (inner side) broadly flattened, presenting a quadrilateral appearance; upper third coarsely punctate.

M. ypsilon Linn.

Hind margin of hypandrium broadly emarginate but not deflexed. Upper and lower side of hypandrium sparsely covered with long hairs. Hypandrial ridge emarginate at centre; emargination located almost on hind margin of hypandrium; from this point the ridge passes back on each side into terminal chamber. Broad proctiger very large and fills up greater part of terminal chamber. It is margined at distal end. Hood of proctiger with a more broad and deep emargination than in M. lugens. Parameres pedunculate; flattened at top. Outer edge of top coarsely punctate. Below each paramere is a smooth depression.

Genus SOLUBEA Bergr. 1891

Solubea pugnax Fabr.

Genital segment of partially open type with more than half the length of segment withdrawn into eighth one. Eighth segment

has two prominent, dark-colored chitinous pleural spines directed caudad situated at the junction of tergite and sternite. Posterior edge of hypandrium broadly emarginate; base of emargination straight. Hypandrial ridge emarginate at middle; distal end of proctiger lies in it. On first observation there seem to be five processes within the terminal chamber, with long hairs numerous. Upon closer observation, what appears to be the middle process is found to be the narrow smooth ridge of the proctiger, due to the extreme lateral compression of the proctiger. The two anterior processes are parameres; and the two posterior processes are the two sharp-pointed, cone-shaped processes situated one at each lateral extremity of hypandrial ridge, and densely covered with long hairs. Pleural process a narrow dark-colored ridge. Parameres long; caudal aspect of right paramere as in Plate II, Fig. 28. Anal processes are two cone-shaped processes situated one on each side of distal end of proctiger; densely covered with long hairs. Terminal chamber comparatively shallow, and external opening very broad.

Genus EUSCHISTUS Dall. 1851

Genital segment of dorsally open type, showing greater part of it free of eighth segment. A side view of segment gives cuneiform appearance. Hypandrium, thin at centre and thickened at sides, extends prominently caudad. Hypandrial ridge not

prominent and located some distance within terminal chamber. Terminal chamber broad and deep enough so that all of genital parts are contained within it. Proctiger transversely ridged and placed in a horizontal position. Parameres vary considerably in shape. Inside of genital chamber, middle of dorsal side of hypandrium, sides and distal end of proctiger, hood of the proctiger, and, outer side of parameres more or less covered with hairs. Hairs also found on sides of genital chamber in the following species: E. servus, E. euschistoides, and E. inflatus.

E. servus Say.

In comparing E. servus and E. euschistoides no definite points of differentiation could be found either in the male or female genitalia. This finding substantiates Van Duzee's (23) statement that: "There certainly seems to be a tendency in these two species to intergrade along the line where their areas of distribution overlap", and that of Blatchley (2): "It is my opinion that a large series from all parts of the United States will show that the two forms are but geographic races of the same species." Hypandrium slightly bowed down at centre and calloused at sides. Hypandrial ridge prominent and broadly emarginate at centre. Outer extremities of ridge enlarged and higher than callouses of hypandrium with which they seem to unite. Hood of the proctiger broadly rounded at the

apex, of the same length, and notched at the middle in both species. Parameres flattened laterally and rather broad at tips.

E. euschistoides Voll.

Genitalia in both male and female are similar to those of E. servus.

E. conspersus Uhler.

All parts of genital segment seen from dorsal view colored black except central area and outer edges of hypandrium, and anterior part of genital chamber on each side of proctiger which is light brown. Parameres dark brown. Hypandrium bowed down at centre with a ridge-like callous on each side. Hypandrial ridge prominent, and emargination at centre angular. Outer extremities of ridge enlarged and merge into callouses of hypandrium. Hood of proctiger narrowed and slightly flattened at apex; also notched at centre. Parameres trilateral, slightly flattened at tip but not as broad as in E. servus.

E. tristigmus Say.

Hypandrium more deeply bowed at centre than in the preceding species; below centre of hypandrial ridge a broad, smooth, rounded cavity, more definite than in preceding species. Broad ridge-like callouses on each side project slightly caudad, giving to posterior edge of hypandrium, when observed from ven-

tral side, the appearance of having two blunt processes. Hypandrial ridge emargination at centre broadly angulate. The enlargements of lateral extremities merge so completely with hypandrial callouses they appear as one. Hood of proctiger tapers caudad at apex into a blunt process. Parameres compressed laterally and broader throughout than parameres of preceding species, thus giving parameres a stouter appearance.

E. tristigmus Say, var. pyrrhocorus H.S.

Description of genital segment as stated for E. tristigmus corresponds to this variety with the exception of following differences: Process at apex of hood of proctiger longer and more pointed. Emargination at centre of hypandrial ridge deeper and acutely angulate. Area of dark pigment on callouses of hypandrium not as extensive.

E. variolarius P.B.

Black spot on ventral side of genital segment characteristic of this species. Structure of genital segment almost identical with that of E. servus, except that the emargination at centre of hypandrial ridge is so broad and deep that ridge itself is negligible. Parameres as in E. servus.

E. ictericus Linn.

General appearance of genital segment of this species similar to that of E. variolarius except hypandrial callouses

broader, centre of hypandrium bowed down slightly more, hypandrial ridge at base of emargination more prominent and thin edged, parameres narrower; and dark pigmentation of hypandrial callouses located only in centre of callouses.

E. inflatus Van D.

Middle of hypandrium bowed downward with callouses at sides. Hypandrial ridge as in E. servus, but enlarged extremities merge completely with callouses of hypandrium so that a longitudinal, slightly curved broad ridge is formed, which is black in color as in E. variolarius. Proctiger brown in color as in E. conspersus. Hood of proctiger flattened and notched at apex; whole hood more rounded than in E. conspersus and less so than in E. servus. Parameres long in comparison to all other species of Euschistus studied.

E. crassus Dall.

Structure of genital segment of this species so different from those of all other species of the genus Euschistus that it at first appears to belong to another genus. Careful study brings out the fact that all homologous structures are present but in more compact form. External opening to terminal chamber bell-shaped. Hind margin of hypandrium slightly sinuate. Hypandrial ridge prominent with extremities enlarged and merging with thickened margin of hypandrium. On inside of ridge, set askew, are two long, coarsely punctate, bulbular, spindle-

shaped ridges. In centre of hypandrium between its hind margin and hypandrial ridge is a rather deep, hollowed-out area. On each side within terminal chamber are broadly swelled areas, at the anterior extremity of these, a small chitinized ridge. Hood of proctiger flattened and emarginate at apex; emargination incised at centre. Parameres very broad and flattened; narrow upper edge wedge-shaped.

E. politus Uhler.

Hind margin of hypandrium deeply notched at centre with small notch on each side of centre notch. Hypandrial callouses merge with expanded extremities of hypandrial ridge. Calloused areas black. Hypandrial ridge narrowly emarginate and deflexed. Hood of proctiger broadly oval, flattened, and broadly emarginate at apex. On each lateral wall of terminal chamber two vertical parallel ridges, which are light colored. Parameres broadly flattened laterally; posterior edge rounded and enlarged; dorsal extremity of edge extends for some distance above body of paramere. Inner side of paramere resembles outline of human ear.

E. bifibulus P.B.

Hind margin of hypandrium slightly sinuate; entire hypandrium is strongly bowed down. Hypandrial ridge thin and deflexed at centre, but at lateral extremities perpendicular to hypandrium. On ridge two bulbular expansions, located one on each side, half way between centre and wall of terminal chamber.

These expansions absorb the definite ridge at points where located. External opening of terminal chamber bell-shaped as in E. crassus, and sides inflexed. The broadly rounded hood of proctiger has an extremely broad emargination at apex. Parameres compressed laterally, very broad - broader than in E. servus.

E. crenator Fabr.

Hind margin with broad shallow emargination at centre. Hypandrium at centre bowed down with sides flaring out, giving to segment a scoop-like appearance. Hypandrial ridge short and deflexed; extremities disappear into two irregular-shaped callosities. Hood of proctiger narrowly oval, apex projecting caudad; emarginate at centre. Paramere resembles E. politus though posterior edge not thickened as E. politus.

Genus PROXYS Spin. 1837

Proxys punctulatus P.B.

Genital segment of partially open type. Hypandrium broadly emarginate with hypandrial ridge also emarginate. Only a small portion of this segment extends out of eighth, and segment is longer, more cylindrical in shape than found in most species of Pentatomidae. A row of long bristle-like hairs along the ventral side of posterior edge of hypandrium. Terminal chamber rather deep. Proctiger transversely ridged, possessing two small tubercles situated one on each side near the distal

end, as in Coenus delius Say. A small ridge-like pleural process on each side. Two prominent sternal ridges run from hypandrial ridge forward into terminal chamber. These elevations covered with hairs. A furrow between them, and distal end of proctiger extends into it. Parameres long and strongly curved upward. Inner aspect of left paramere shaped as in Plate II, Fig. 27.

Genus COENUS Dall. 1851

Coenus delius Say.

Genital segment of dorsally open type with greater part of segment free of eighth. Hypandrium turns upward and gives end of abdomen a rounded appearance. Hypandrium broadly emarginate with a characteristic spine at centre. Hypandrial ridge narrowly emarginate at centre. Between edge of hypandrium and hypandrial ridge is a pit containing a rather prominent sharp pointed-spine which seems to have originated from hypandrial ridge. Proctiger transversely ridged, with two small tubercles situated one on each side near the distal end. Terminal chamber, except parameres, practically covered with rather long hairs. Very small in comparison to size of genital segment. Parameres prominent, blunt and strongly curved anteriorly.

Genus HYMENARCYS Am. & Serv. 1843

Genital segment of dorsally open type, with proctiger lying in horizontal position. About one-half of total length free of eighth segment. Outer edge of terminal chamber broadly

flattened all around except tergal part. Proctiger transversely grooved. General shape of segment similar to that of genus Euschistus though posterior edge of hypandrium more blunt and therefore thicker. Hypandrium deflexed. Ventral side of segment covered with small hair-bearing punctures.

H. nervosa Say.

Internal aspect of segment covered with hairs. Broad hypandrial edge slopes inwardly and marked by minute irregular lines which converge towards hypandrial emargination. Hypandrial ridge broadly emarginate at centre; at base of emargination the thin ridge is barely traceable. On each side ridge merges into long, bulbular, hair-bearing callouses. Laterally the continuation of ridge represented by broad, smooth, light-colored prominence, which continues anteriorly into terminal chamber along sides. Apex of hood of proctiger smooth and slightly flattened. Parameres erect, flattened laterally, taper towards distal end; tip end bends rather abruptly anteriorly. On outer side at base they are densely covered with hairs.

H. crassa Uhler.

Hypandrial edge broader and more nearly in same plane as remainder of edge than in case of H. nervosa. Hypandrial ridge bends anteriorly into terminal chamber. Callouses are not as large nor as prominent as in H. nervosa. Ridge at base of broad centre emargination just traceable. No continuation of ridge laterally from callouses. Hood of proctiger broadly

flattened with a broad shallow emargination at apex. Flattened area marked by surface irregularities. Parameres as in H. nervosa except that distal end gradually bends caudad.

H. aequalis Say.

Posterior edge of hypandrium more similar to H. crassa than to H. nervosa. Hypandrium broadly concave; posterior to hypandrial ridge. Hypandrial ridge more prominent than in two above mentioned species and extends across hypandrium. Lateral callouses on inner side of ridge, and not covered with hairs as in other two species. Lateral edges of terminal chamber sinuate. Parameres erect, compressed laterally, very broad at base and broader throughout than in case of other two species; hairs on outer side of base; base concave on outer side; broad distal end bends anteriorly. Pleural processes four vertically placed ridges, which grow smaller respectively caudad.

Genus AELIA Fabr. 1803

Aelia americana Dall.

Genital segment of closed type and globose. Ventral side of hypandrium marked with concentric arcs. Median emargination broad; thin chitinous hypandrial ridge extends across emargination. Hypandrial ridge has a similar emargination. Opening of terminal chamber broader than long. Parandria expand laterally, and upper lateral projections deflexed into terminal chamber. Proctiger has prominent knob-like projection at base, from which

two lateral ridges diverge. This gives to dorsal side of proctiger triangular shape. Parameres shaped as in Plate IV, Fig. 77.

Genus NEOTTIGLOSSA Kby. 1837

Genital segment of closed type; entire segment withdrawn into eighth. Posterior view entirely closed due to hypandrium (sternite) turning upward and meeting posterior edge of eighth tergite. Hypandrial ridge indefinite. Dorsal view of parameres a J-shaped structure on each side of proctiger. Parameres biramous, inner branch broadly flattened laterally and spatulate in shape; outer branch tapering with recurved tip. Pleural processes plumose; similar to those found in Peribalus limbolarius Stal and P. abbreviatus Uhler.

N. sulcifrons Stal.

Posterior edge of hypandrium fits close to posterior edge of eighth tergite. Posterior edge of hypandrium has a minute broad emargination at centre. In some specimens emargination rather indefinite as in Plate I, Fig. 2. Posterior expanded edges of parandria turn inward.

N. undata Say.

Posterior edge of hypandrium does not fit as close to posterior edge of eighth tergite as in case of N. sulcifrons. Posterior edge of hypandrium has a rather deep U-shaped emargination at centre. No definite turning inward of posterior expanded edges of parandria.

Genus COSMOPEPLA Stal 1867

Genital segment considered as of closed type even though there is a small opening between caudal edges of hypandrial ridge and eighth tergite. Segment globose. Entire segment withdrawn into eighth. Hypandrium bowed downward; edge directed caudad; hypandrial ridge practically closes terminal chamber because of nearness to tergite of eighth segment. Hypandrial ridge prominent. Proctiger enlarged at base and covered with hair. Pleural processes broad and callous-like; surface finely reticulate. Parameres flattened laterally and curved slightly laterad.

C. bimaculata Thom.

Emargination on caudal edge of tergite broad and angular; at base of emargination is a broad bilobed median protuberance. Paramere similar to that of C. uhleri but thinner.

C. uhleri Montd.

Caudal edge of tergite bowed cephalad, with a broad median protuberance notched at middle of caudal edge. Paramere shaped as in Plate IV, Fig. 63.

C. conspicillaris Dall.

Caudal edge of tergite as in C. uhleri, except that median protuberance slightly broader, and notch not as deep. Paramere similar to C. uhleri.

C. decorata Hahn.

Caudal edge of tergite as in C. uhleri except that median protuberance scarcely traceable; notch broad and shallow. Inner view of left paramere shaped as in Plate IV, Fig. 62.

Genus EYSARCORIS Hahn 1834

Eysarcoris intergressus Uhler.

Genital segment of closed type; entire segment withdrawn within eighth. Segment globose. Ventral side sparsely and coarsely punctate. Posterior edge of hypandrium deflexed. Posterior extremities of sides of segment flare out. Hypandrial ridge prominent across segment. Posterior view of ridge broadly concave; ridge sinuate. Dorsal posterior edge of terminal chamber broadly rounded. Hood of proctiger distinctly separated from tergite. Parameres flattened laterally, shaped as in Plate II, Fig. 26.

Genus MENECLES Stal 1867

Menecles incertus Say.

Genital segment partially open type; about one-half of segment protrudes from eighth. Segment cuneiform. Hypandrium deeply bowed downward at centre; ventrad concave on each side. Hypandrial ridge with narrow emargination at centre. Ridge very thick throughout; merges on either side as large flattened callouses into lateral extremities of hypandrium. A deep broad depression located beneath hypandrial ridge. Proctiger transversely ridged; distal end covered with hairs. Hood

of proctiger broadly flattened at apex. Parameres at base broadly flattened laterally, thickened at caudal edge; rounded distal tip strongly recurved. This segment similar to segments found in genus Euschistus. The characteristic recurved paramere differentiates it.

Genus PRIONOSOMA Uhl. 1863

Prionosoma podopioides Uhler.

Genital segment of dorsally open type and about one-half withdrawn into eighth. Posterior edge of hypandrium bowed down, sparsely covered with hairs, and slightly concave on each side posteriorly. Ventrally entire segment is sparsely covered with broad hair-bearing punctures. Tergite broadly convex. Lateral thin edge of terminal chamber sinuate; fringed with hairs. Hypandrial ridge with broad and deep emargination at centre. Ridge merges laterally into large flattened callouses. Proctiger very broad in comparison to remainder of segment; transversely ridged. Parameres erect, concave on outer side, flattened laterally at base, cylindrical towards distal end, rounded tip; paramere as a whole bends gradually anteriorly. Pleural process represented by long narrow ridge.

Structure of genital segments very similar to genus Hymenarcys.

Genus THYANTA Stal 1862

Genital segment of partially open type and typically half withdrawn within eighth. Posterior lateral angles of eighth

segment project posteriorly even with or beyond posterior extremity of genital segment. Hypandrium (may include hypandrial ridge) flattened posteriorly; usually marked with concentric arcs. Exposed or external parts of segment covered with hairs. Six species studied may be divided into two groups, i.e., those with parandria expanded as T. antiguensis, T. rugulosa and T. punctiventris and those with parandria contracted as T. perditor, T. custator and T. casta. The condition in these two groups is therefore a widely open terminal chamber in former, and greatly reduced opening to terminal chamber in latter.

T. perditor Fabr.

Hypandrial ridge arcuate and emarginate at centre. Sides of emargination swollen. Proctiger with a slight protuberance on each side of base; a traceable median longitudinal groove dorsad, with slight expansion at middle. Parameres almost hidden, but portion showing shaped as in Plate II, Fig. 29.

T. custator Fabr.

Hypandrial ridge arcuate. Proctiger broadly ridged at base, and sides parallel. Parameres almost hidden, portion showing shaped as in Plate II, Fig. 30.

T. casta Stal.

Hypandrial ridge arcuate only at centre. Proctiger capitate at base; sides slightly converge. Parameres almost

hidden, but portion showing shaped as in Plate II, Fig. 31.

T. antiguensis Westw.

Hypandrial ridge broadly arcuate-emarginate at centre. Proctiger concave at middle of dorsal side and slightly constricted at distal end. Hood of proctiger notched at centre of caudal edge. Parandria greatly expanded, more so than in case of T. rugulosa. Paramere shaped as in Plate II, Fig. 34.

T. rugulosa Say.

Hypandrial ridge narrowly emarginate at centre. Parandria expanded more so than in T. punctiventris and less than in T. antiguensis. Proctiger slightly expanded at base; sides parallel. Paramere shaped as in Plate II, Fig. 33.

T. punctiventris Van D.

Hypandrial ridge with small median emargination. Parandria expanded less than in case of T. rugulosa. Proctiger grooved along mid-dorsal line, slightly constricted at middle. Paramere shaped as in Plate II, Fig. 32.

Genus CHLOROCORIS Spin. 1837

Chlorocoris atrispinus Stal.

Genital segment of open type and entirely withdrawn within eighth. Segment globose. Median emargination on posterior edge of hypandrium broad and shallow; on each side of emargination on dorsal side large callouses. All structures

(except parameres) within terminal chamber; walls are ridged. Hypandrial ridge transversely ridged; emarginate at sides; centre produced into tri-lobed projection directed caudad. Cup-like pleural processes on inner side transversely ridged. Proctiger deeply concave for half length of dorsal side, is transversely ridged, and prominently margined. Two sides of proctiger project for a distance equal to proctiger proper; these projections bend cephalad at middle so that distal half lies dorsal to basal half. Basal half sparsely covered with long hairs. The parameres very irregular shape as shown in Plate IV, Fig. 76, and sparsely covered with long hairs.

Genus LOXA Am. & Serv. 1843

Loxa florida Van D.

Genital segment of partially open type; about one-third of length of segment withdrawn within eighth. Lateral view of segment cuneiform. Though the adult specimens of Chlorocoris atrispinus Stal and Loxa florida are of about the same size, genital segment of latter is about four times size of former. Hypandrium deeply emarginate; emargination V-shaped. Terminal chamber beset with hairs. Opening of terminal chamber, on dorsal side, has a spine projecting into chamber from centre of each lateral edge. Hypandrial ridge greatly thickened, with median bilobed projection directed dorsad. Dorsal edge concave. Proctiger broad at base; constricted at mid-

dle; dorsal side of basal half smooth; distal half concave; floor of concavity covered with ridges which radiate from distal end. On each side of concavity a broad obtuse spine projects dorsad. Paramere very irregular in shape as partially shown in Plate IV, Fig. 66, or dorsal view. Greater part of paramere covered with short hairs.

Genus MURGANTIA Stal 1862

M. histrionica Hahn.

Genital segment of partially open type; almost the entire segment withdrawn within eighth. Hypandrium flares out; greatly thickened at sides; callouses, one on each side, prominent and cone-shaped. Hypandrial ridge, at centre, comes to hind margin of hypandrium. At this point both hind margins of hypandrium and hypandrial ridge broadly emarginate. Hypandrial ridge sinuate at sides and continues upward, merging with low ridge of base of hood of proctiger. All exposed parts of terminal chamber, with exception of parameres and above mentioned ridges, covered with hairs. Proctiger greatly enlarged at base, constricted at middle; at the distal end turns up abruptly. Dorsal side concave for entire length. Heavily chitinized pleural processes tooth-like; extend into the terminal chamber. Parameres project upward; posterior view as in Plate II, Fig. 25.

Genus NEZARA Am. & Serv. 1843

Genital segment of partially open type, and entire segment, except projecting sides of hypandrium and hypandrial ridge; withdrawn within eighth segment. Segment globose. Posterior side of hypandrial ridge marked ventrally with concentric arcs. Parandria concave beneath; dorsal side covered with long hairs. Hood of proctiger round at apex. Proctiger covered with hairs, slightly flattened dorsally, and sides parallel. An area within terminal chamber, above parameres, on each side, is a densely tufted area. Parameres erect; inner sides parallel to sides of proctiger.

N. viridula Linn.

Hypandrial ridge with greater curvature than in N. viridula, var. torquata. Paramere, posterior view, shaped as in Plate III, Fig. 35.

N. viridula, var. torquata Fabr.

Hypandrial ridge with slight curvature. Parameres, posterior view, shaped as in Plate III, Fig. 36.

Genus ACROSTERNUM Fieb. 1861

Genital segment of partially open type though proctiger lies in horizontal position in terminal chamber. Practically entire segment withdrawn within eighth. In all three species studied segment of a light green color. Segment cuneiform.

Hypandrial ridge marked ventrally with concentric arcs as in genus Nezara. Lateral projections of edges of ridge fold abruptly over into terminal chamber. Posterior edge of hypandrium not prominent, but is distinctive in species. Proctiger concave dorsally at base, broadens out at middle; sides converge slightly toward distal end. Terminal chamber beset with hairs. Parameres broadly flattened laterally and taper distally.

A. hilaris Say.

Lateral projection of hypandrial ridge fold, on outer side; edged with black-colored blunt projections. Hood of proctiger more flattened at apex and longer either A. pennsylvanicum or A. marginatum. Ventral view of posterior edge of hypandrium as in Plate IV, Fig. 80.

A. pennsylvanicum DeGeer.

Distal end of lateral projection of ridge-fold more tapering; outer side not edged with blunt projections as in A. hilaris, though there is a trace of projections on dark-colored edge. Hood of proctiger flattened at apex; sides of flattened area converge distally. Ventral view of posterior edge of hypandrium as in Plate IV, Fig. 79.

A. marginatum P.B.

Distal end of lateral projection of hypandrial ridge-fold and outer side as in A. pennsylvanicum. Hood of proctiger

more rounded at apex than in two preceding species; more distinctly differentiated dorsally from tergite of segment. Ventral view of posterior edge of hypandrium as in Plate IV, Fig. 78.

Genus BANASA Stal 1860

Genital segment of partially open type, almost all of which is withdrawn within eighth. Segment globose and cuneiform; covered outside and within terminal chamber with hairs. Hypandrial ridge and hood of proctiger present in all species. Caudal edge of hypandrium broadly emarginate.

B. dimidiata Say.

Hypandrial ridge with a broad median protuberance; at each lateral extremity a rather long peg-like protuberance directed dorsad. Caudal part of tergite declivent. Proctiger (dorsad) flattened at base, calloused on each side at middle, and slightly tapered at distal end. Hood of proctiger prominent with sides explanate. Paramere broadly flattened laterally, concave on inner side, entirely covered with hair. Edge of paramere directed caudad.

B. subrufescens Walk.

Hypandrium thickly covered with long hairs. Hypandrial ridge small, thin, inconspicuous, with broad median emargination. Instead of extending across hypandrium it passes around distal end of proctiger. Proctiger with a prominent mid-dorsal

longitudinal ridge and slightly constricted at middle. Hood of proctiger narrowly arched at apex. Parameres trilateral, elongate, flattened at tips. Shaped as in Plate IV, Fig. 68.

B. calva Say.

Hypandrial ridge base merges with caudad edge of hypandrium, so is not easily differentiated from it. Emarginate like hypandrium. Lateral extremities do not fuse with parandria but are angular. Proctiger enlarged at base, has a mid-dorsal longitudinal ridge. Hood of proctiger arched at apex, but not prominent as in case of B. dimidiata or B. euchlora. Paramere shaped as in Plate IV, Fig. 70.

B. sordida Uhler.

Hypandrial ridge broadly arcuate with a median notch. Proctiger enlarged and ridged at base, sides converge slightly towards distal end, a mid-dorsal longitudinal ridge present but not prominent, and surface rough. Hood of proctiger arched at apex. Paramere (caudal view) shaped as in Plate IV, Fig. 69.

B. packardi Stal.

Hypandrial ridge thin and translucent; emargination angulate at base. Proctiger with prominent mid-dorsal longitudinal ridge and slightly expanded at base. Hood of proctiger arched and fits closely about base of proctiger. Paramere shaped as in Plate IV, Fig. 71.

B. euchlora Stal.

Hypandrial ridge with small, rounded, median emargination; protuberances at lateral extremities larger than B. dimidiata. Proctiger enlarged at base. Hood of proctiger does not extend ventrad along sides of proctiger as B. dimidiata. Covers base of proctiger and thickened at lateral deflexed edges. Parameres as in B. dimidiata.

B. imbuta Walk.

Hypandrial ridge emargination arcuate; sides of ridge rounded and flexed dorsad. Proctiger smooth and very broad. Hood of proctiger fits closely to base of proctiger and is broadly arched. Pleural processes callous-like. Paramere shaped as in Plate IV, Fig. 67.

Genus PIEZODORUS Fieb. 1861

Piezodorus guildinii Westw.

Genital segment of dorsally open type; entire segment withdrawn into eighth. All exposed parts, except part of hypandrium, covered with hairs. Sides of segment almost parallel. Opening to terminal chamber strictly dorsal and entirely closed, flush with the tergite, by dorsal side of proctiger; irregular-shaped parameres on either side of it. Therefore no study can be made of internal structure of terminal chamber. Hypandrium turns upward abruptly to meet end of proctiger. At centre of posterior edge of hypandrium a narrow emargination.

On each side of hypandrial emargination an elongate callous covered with erect hairs. Due to an angular depression, posterior view of hypandrium is made up of three planes - bottom and two sides. Thin hypandrial ridge follows posterior edge of hypandrium. Parameres, dorsal view, shaped as in Plate III, Fig. 37. Distal ends bent laterally. Adjacent to outer side of each paramere is a cup-like structure which may be a pleural process.

In a comparison of the genital segment of this genus with that of the genus Meadorus the greatest divergence from the typical genital segment of Apateticus is noted.

Genus ARVELIUS Spin. 1837

Arvelius albopunctatus DeGeer.

Genital segment of open type; almost entirely withdrawn into eighth. Posterior view shows walls of terminal chamber thick. Segment almost globose, and of a light yellow color. Hypandrium with a broad, deep emargination at centre, base of which is straight. Covered with hairs dorsally and ventrally. Parandria flare out, but slight convergence at posterior ends. Tergite edge deeply emarginate, sides of which are irregular. Hypandrial ridge separated by hypandrial emargination. Ridge thickened at lateral extremities; since ridge is not continuous, two sections pass longitudinally back into terminal chamber, in line with sides of hypandrial emargination. Style-like

pleural process covered by broad paramere so that only distal tip of process appears above paramere. Hood of proctiger covered by edge of tergite. Hood has a semi-circular emargination at apex. Parameres shaped as in Plate III, Fig. 38.

Genus DENDROCONIS Bergr. 1891

Genital segment of partially open type (opening due to deep emargination of hypandrium); almost entirely withdrawn into eighth, though segment slightly protrudes due to bulging of sternite. Posterior lateral projections of hypandrium bent abruptly cephalad; distal end of each projection varies considerably in length and shape. Hypandrial projections marginate. Parameres and pleural processes present; set well back in terminal chamber.

D. humeralis Uhler.

Hypandrial projections bend outwardly. Of two distal projections outer one at least twice the size of inner, and more heavily chitinized. Distal end of proctiger abruptly but slightly constricted. Thinly chitinized hypandrial ridge appears to be situated across base of hypandrial emargination; emargination narrow and deep. Two small emarginations, one on each side. Paramere shaped as in Plate IV, Fig. 73.

D. fruticicola Bergr.

Hypandrial projections bend outwardly. Distal projections more separated at base than D. humeralis; comparatively

larger. Hypandrial ridge and proctiger similar to D. humeralis. Paramere shaped as in Plate IV, Fig. 72.

D. reticulatus Barb.

External opening to terminal chamber much smaller than other three species of Dendrocoris studied. Gives to segment more compact appearance. Hypandrial emargination wider and not so deep as in case of other three species. Hypandrial ridge regular in outline. Hypandrial projections not prominent as in D. humeralis. Distal projections traceable; only a small chitinized ridge remains of outer one. Posterior edge of hypandrial projection has shape of an inverted "question-mark". On ventral side of hypandrium, near centre, are two hooked spines. Parameres shaped as in Plate IV, Fig. 74.

D. contaminatus Uhler.

Distal projections of hypandrial projections vary from those of other species of Dendrocoris in that inner projection is barely traceable, while outer one is very broad at base but not as long as in case of D. humeralis or D. fruticicola. Hypandrial projections strongly concave for full length on ventral side. Hypandrial ridge at base of hypandrial emargination similar to that of D. humeralis, but median emargination not as deep. Parameres shaped as in Plate IV, Fig. 75.

Genus EREPHOLOXA Van D. 1904

Brepholoxa heidemanni Van D.

Genital segment of partially open type, due to a rather deep hypandrial emargination, except protuberances of hypandrium; entirely withdrawn within eighth segment. Eighth sternite deeply and broadly emarginate. Segment elongate. Hypandrium turns upward so that greatly thickened posterior edge is level with dorsal side of segment. Sides of hypandrium diverge from hypandrial emargination. At base of hypandrial emargination a small thin hypandrial ridge connecting sides of emargination. On each side of emargination a flattened, thick-edged protuberance directed ventrally. Dorsal aspect of terminal chamber covered with long hairs; at base is a heavily chitinized protuberance. A side view of segment shows a rather deep incisure between hypandrium and sides of segment. Hypandrium, on each side, concave posterior to incisure. Parameres milky-white in color with flattened sub-triangular shaped distal end dark brown. Flattened distal ends of parameres face anteriorly, usually touching pleural processes. Pleural processes directed caudad, blunt and peg-like, appear to be finely tuberculate.

Genus ADESSA Fabr. 1803

Genital segment of partially open type, the greater part withdrawn into eighth. Exposed part sparsely covered with hairs. Hypandrium emargination deep and broad.

E. bifida Say.

Hypandrial emargination rounded at base. Hypandrial ridge present as a slight ridge. Terminal chamber profuse with hairs. Proctiger smooth, cylindrical, and with trace of transverse grooves. Parameres broadly flattened laterally; inner view triangular in shape with posterior angle bent outward. Pleural processes much larger than in E. meditabunda; inner view triangular with angles acuminate.

E. meditabunda Fabr.

Hypandrial emargination straight at base. Hypandrial ridge absent. Terminal chamber more profusely covered with hairs than in E. bifida. Proctiger strongly constricted at middle on dorsal side. Above constriction rounded and smooth; below flattened and triangular in shape. Pleural processes flattened at top, slightly pedunculate, and project into terminal chamber. Parameres erect, stout and trilateral.

Genus MEADORUS M. & R. 1866

Meadorus lateralis Say.

Genital segment of open type, though as it appears in normal position it might be considered a ventrally open type. Segment entirely withdrawn into eighth. Very unique in form. Segment rather long and slender in comparison to species studied in other genera. Posterior edge of tergite with broad deep emargination; on each side of emargination edge fringed with

long hairs. Ventral view of hypandrium gives it a semi-circular form; each side terminated by a tri lateral spine. At centre a fringe of long hairs. Hypandrial ridge absent at centre for space about equal to width of hypandrial fringe of long hairs. On each side it curves upward and disappears back of parameres. Proctiger has a long median distal spine directed almost caudad. Parameres long and flattened dorso-ventrally. The ventral view shaped as in Plate III, Fig. 39.

Genus ELASMOSTETHUS Fieb. 1861

Elasmostethus cruciatus Say.

Genital segment of open type; all but part of sternite withdrawn into eighth. Segment globose. Parameres extend almost entirely out beyond hypandrial ridge through side emarginations in ridge. Flattened dorso-ventrally and slant slightly upward. Ventral view of paramere as in Plate III, Fig. 43. Hypandrium posterior edge thick; with trace of a median emargination. On each side of emargination is a double fringe of dark long hairs, covering area between two black-colored prominent spines. Hypandrial ridge has a deep, broad emargination at centre; on each side a smaller emargination through which parameres pass. Proctiger smooth, broad at base, sides converge toward rounded distal end; distal half curves upward. Proctiger situated well back in terminal chamber. Posterior edge of tergite very thick; on each side of median line is a small group of long hairs directed caudad.

Genus STIRETRUS Lap. 1832

Genital segment of partially open type; almost entirely withdrawn within eighth. Segment globose. Exposed portion of segment and terminal chamber beset with hairs. Hypandrial emargination deep and broad. Hypandrial ridge with broad emargination at centre; not as broad or deep as that of hypandrium; angular at base; lateral edges extend beyond edge of hypandrium. Proctiger broadest at base with a median longitudinal ridge. Pleural process cup-shaped, broadly emarginate on outer edge, upper edge smooth and rounded, lower and inner edges irregular in outline; in lower part of cup a trace of tubercles similar to those of Apateticus. Hood of proctiger very broad; lateral extremities extend back of pleural processes. Parameres thin and broadly flattened laterally.

S. anchorago Fabr.

Paramere shaped as in Plate III, Fig. 47.

S. anchorago, var. fimbriatus Say.

Paramere shaped as in Plate III, Fig. 44.

S. anchorago, var. violacens Say.

Paramere shaped as in Plate III, Fig. 40.

In this study a typical specimen has been chosen and two definite varieties. The two varieties can be readily separated by the shape of the parameres, though it may be noted that the

paramere of S. anchorago var. fimbriatus can be readily separated from S. anchorago and S. anchorago var. violacens, but this is not so easily done with S. anchorago and S. anchorago var. violacens.

Genus ALCAEORRHYNCHUS Bergr. 1891

Genital segment of open type; almost entirely withdrawn within eighth. Ventral side sparsely covered with hairs directed caudad. Hypandrial ridge thin and translucent. Between hypandrium and hypandrial ridge a broad oval-shaped depression. On inner side of hypandrial ridge are two horizontal ridges, one on each side of distal end of proctiger. Parandria flare out and extend caudad. Proctiger sparsely covered with hairs; has a median longitudinal ridge. Cup-shaped pleural processes smooth and broadly notched on outer side.

A. grandis Dall.

Hypandrium emargination deep and broad; posterior margin thick with a rather broad, rough, calloused area covered with long bristles. Hypandrial ridge with a broad shallow emargination at centre and sinuate at sides. Outer side sparsely covered with long hairs. Proctiger with upper half transversely wrinkled. Parameres long; distal half extremely flattened laterally. Inner side of flattened area shaped as in Plate IV, Fig. 61.

A. phymatophora P.B.

Hypandrial emargination not as broad but more semi-circular in form than in A. grandis. Posterior edge at sides of emargination greatly thickened. Hypandrial ridge median emargination not as broad but slightly deeper than in A. grandis. Proctiger with a raised reticulation over entire exposed surface. Pleural process grooved on dorsal edge. Paramere shaped as in Plate IV, Fig. 60.

Genus OPLOMUS Spin. 1837

Genital segment of partially open type; segment entirely withdrawn within eighth. Segment globose and beset with hairs outside and within terminal chamber. Hypandrium, ventral view, broadly emarginate; caudal edge on both sides of emargination folds back into terminal chamber. Hypandrial ridge thin and translucent, with a broad, shallow, median emargination. Proctiger covered with fine hairs. Pleural processes cup-like, tuberculate and grooved on dorsal edge. Parameres broadly flattened dorsally with thin edge dorsad.

O. mundus Stal.

Proctiger with only a trace of median longitudinal ridge and narrowed at base. Paramere more tapered at distal end and narrower at base than in O. pulcher.

O. pulcher Dall.

Proctiger with a distinct median longitudinal ridge. Paramere broader at tip and much thicker at base than in case of O. mundus. O. pulcher was used with O. mundus for comparison because no other species from the United States was available.

Genus PERILLUS Stal 1862

Genital segment of partially open type; almost entirely withdrawn within eighth. Globose in shape. Hypandrium at posterior edge turns slightly upward. Hypandrial ridge covers about one-fourth of opening of terminal chamber; posterior edge irregular. Slight emargination at centre of posterior edge; a broad indenture in centre of caudad phase of hypandrial ridge. Proctiger ridged for almost entire length along mid-dorsal line. Parameres of a more or less triangular shape. Pleural processes cup-shaped and edged with tubercles, except on outer edge.

P. bioculatus Fabr.

Broad indenture in centre of hypandrial ridge shallow in comparison to either P. circumcinctus or P. exaptus. Paramere shaped as in Plate III, Fig. 41. Interior of cup-shaped pleural process free of tubercles.

P. circumcinctus Stal.

The broad indenture in centre of hypandrial ridge rather deep. Paramere shaped as in Plate III, Fig. 45. Interior of cup-shaped pleural processes covered with tubercles.

P. exaptus Say.

Interior of cup-shaped pleural processes covered with tubercles. Paramere shaped as in Plate III, Fig. 42.

P. confluens H.S.

Pleural process not as elongate as in above three species studied; a prominent tubercle near the centre of the cup. Paramere shaped as in Plate III, Fig. 46.

Genus EUTHYRHYNCHUS Dall. 1851

Euthyrhynchus floridanus Linn.

Genital segment of partially open type, having about one half its length extend out free of eighth segment. Globose ventrally. The external parts more or less covered with straight bristly hairs. Posterior part of tergite wrinkled transversely. Hypandrial emargination angulate at base, and caudal edge; on each side of emargination, thickened. Hypandrial ridge thin, extends across base of hypandrial emargination; emargination broad. Proctiger has a mid-dorsal longitudinal ridge. Paramere flattened laterally, sinuate and long, extending beyond posterior edge of hypandrium. Pleural process

extending ridge-like out into terminal chamber; ridge irregularly serrate. Sternal process, black, small, broad base, and ridged longitudinally.

Genus MINEUS Stal 1867

Mineus strigipes H.S.

Genital segment of partially open type; almost entirely withdrawn within eighth segment. Hypandrial ridge with a minute broad emargination at centre of posterior edge, on each side a blunt tooth. A broad indenture at centre of caudad phase of hypandrial ridge; unlike genus Perillus, includes a portion of posterior edge of hypandrium. Proctiger ridged for entire length along mid-dorsal line. Parameres triangular in shape as in Perillus. Pleural process cup-shaped, edged with tubercles except on outer side.

Genus APATETICUS Dall. 1851

Genital segment fitting closely and drawn entirely within eighth. Posterior view of genital segment of open type. Pleural process multi-tuberculate. Prominent tubercle in centre of posterior aspect of proctiger. Dorsal side of hypandrium covered with dark bristle-like hairs. Hypandrial ridge process, flattened dorso-ventrally; covered at extremity with two masses of long declivent hairs, tips of which meet along middle line. Parameres biramous.

A. cynicus Say.

Upper branch of paramere slender, flattened laterally and shorter than lower branch. Lower branch flattened laterally and saber-like. Dorsal view of segment as in Plate III, Fig. 57.

A. bracteatus Fitch.

Branches of paramere about equal length. Upper branch with a broader base than in A. cynicus and not definitely flattened laterally. Dorsal view of genital segment as in Plate III, Fig. 55.

A. crocatus Uhler.

Parameres similar to those of A. bracteatus. Pleural processes have fewer tubercles throughout central area. Dorsal view of genital segment as in Plate III, Fig. 56, shows a deeper and less broad emargination of posterior edge of tergite. This is the species that Van Duzee (1904) thought might be merged with A. bracteatus because he could distinguish it from A. bracteatus only in color.

Genus PODISUS H.S. 1853

Genital segment of partially open type except P. accutissimus. Fits in closely; drawn almost entirely within eighth segment. Laterally and ventrally sparsely covered with hairs. Proctiger covered with long bristle-like hairs. Para-

meres of a more or less trilateral shape except in P. mucronatus and P. acutissimus; from posterior view more or less cup-shaped pleural processes are seen to emerge from back of parameres and extend a short distance above dorsal edge of parameres. Dorsal edges of pleural processes rounded. Parandria flare-out laterally and extend beyond hypandrium.

P. maculiventris Say.

Hypandrial ridge has two broad protuberances, one on each side of mid-ventral line. Proctiger has two small blunt protuberances at basal end. Paramere shaped as in Plate III, Fig. 52.

P. serieventris Uhler.

Hypandrial ridge not as prominent at middle as in P. maculiventris. Paramere shaped as in Plate III, Fig. 48.

P. modestus Dall.

Hypandrial ridge not as prominent as in P. maculiventris but more prominent than in P. serieventris. Paramere shaped as in Plate III, Fig. 49.

P. placidus Uhler.

Hypandrial ridge bulbular at each lateral extremity. Due to shape of paramere, more of pleural process appears. Paramere shaped as in Plate III, Fig. 50.

P. sagitta Fabr.

Dorsal edge of pleural process broad, almost as broad as dorsal edge of paramere. Paramere shaped as in Plate III, Fig. 51.

P. fuscescens Dall.

Posterior edge of hypandrium more prominent than in any of other species. Dorsal edge of pleural process narrow, about one-fourth the width of dorsal edge of paramere. Paramere shaped as in Plate III, Fig. 53.

P. mucronatus Uhler.

In this species the entire pleural process can be seen on account of peculiar form of paramere. Surface within cup tuberculate. Paramere shaped as in Plate III, Fig. 54.

P. acutissimus Stal.

Genital segment very different from typical Podisus segment. Of dorsally open type, with proctiger lying parallel to segment. Hypandrium turns abruptly upward; deeply emarginate at centre; caudal edges at sides slightly deflexed. In centre below thin hypandrial ridge, which extends across base of hypandrial emargination, is a deep smooth depression; on either side a slight depression. Upper and lower sides covered with hairs. Proctiger densely covered with long hairs; upper half enlarged and flattened, with a longitudinal ridge extending down middle of dorsal side. Parameres not tri-

angular in shape as in other species of Podisus studied. Broadly flattened laterally, and sabre-like. Pleural processes cup-shaped and edged with tubercles except on outer side as in Mineus strigipes H.S.

Genus ZICRONA Am. & Serv. 1843

Zicrona caerulea Linn.

Genital segment of partially open type. Broad central extension of tergite of eighth segment passes beyond posterior edge of hypandrium so that at first segment appears to be of closed type. Segment withdrawn entirely within eighth. Proctiger sparsely covered with long hairs. Paramere shaped as in Plate IV, Fig. 59.

DISCUSSION

The author realizes that the finding of new characters in the genitalia, no matter how definite and unvariable they are, cannot be considered as establishing the species without reference to the other previously established external characters. The combination of all other known characters of a species with those obtained through the study of the genitalia will offer a more exact description of that species so that its identification at any time or place may be more readily determined.

In review, we find that the genital segments of male Pentatomidae may be divided into four groups each having a

different type of external appearance.

The Closed Type contains 4 genera and 8 species. The genera are:

AELIA
COSMOPEPLA
EYSAROCORIS
NEOTTIGLOSSA

The Dorsally Open Type contains 5 genera and 18 species. The genera are:

COENUS
EUSCHISTUS
HYMENARCYS
PIEZODORUS
PRIONOSOMA

The Open Type contains 9 genera and 15 species. The genera are:

ALCAEORRHYNCHUS
APATHETICUS
ARVELIUS
CHLOROCORIS
ELASMOSTETHUS
MEADORUS
MINAEUS
PERILLUS
PLATYCARENUS

The Partially Open Type contains 26 genera and 68 species. The genera are:

ACROSTERNUM
BANASA
BREPHOLOXA
BROCHYMENA
CARPOCORIS
CHLOROCHROA
DENDROCORIS
EDESSA
EUTHYRHYNCHUS
LOXA
MECIDEA
MENECLES
MORMIDEA
MURGANTIA
NEZARA
OPLOMUS
PERIBALUS
PODISUS
PROXYS
RHYTIDOLOMIA
SCIOCORIS
SOLUBEA
STIRETRUS
THYANTA
TRICHOPEPLA
ZICRONA

The genital segment is generally globose in shape with the anterior foramen more or less circular and the caudal end varying from a rather blunt contour to the cuneiform. These characteristics were given due consideration in the write-ups of the species.

The hypandrium varies a great deal in shape, thickness, and direction of the caudal edge. Often, as in Euschistus, it is very prominent or deeply emarginate at centre of caudal edge as in Arvelius or greatly thickened at sides as in Murgantia. Sometimes it is directed dorsad to meet the posterior edge of eighth tergite as in Neottiglossa, thus closing the genital segment. Furthermore it may be practically absent as in Apateticus. Usually when the parandria are expanded and their edges extending beyond the caudal edge of the hypandrium, the hypandrium is prominent. The parandria are well exemplified in Brochymena. These variations have been of utmost value to the author in the specific descriptions.

Of perhaps more taxonomic importance than the hypandrium is the hypandrial ridge. Its contour, thickness, and position in respect to the hypandrium is important among all the genera. It is most typical in Peribalus, almost absent in Edessa, and shows greatest modification in Loxa.

The proctiger "is the most remarkable of the external male characters in Pentatomidae" (19). Its shape, position

in the terminal chamber, and all of its structural variations make it very important taxonomically. Usually it tends to be perpendicular to the sternite, but in the dorsally open type and closed type of genital segment it is horizontal to the abdomen.

The parameres are present in all genera except one (Sciocoris). They are always located in the same general position, on each side of the proctiger, and their shape and structure are so variable in the species that the parameres have been distinctly described or compared in the write-up of each species.

The so-called pleural processes are peculiar structures which do not occur in all species. Their variability in position in the terminal chamber and shape give no clew to their function. They show the greatest specialization in Apateticus and Peribalus (Plate II, Fig. 16).

After making a study of the above structures it is interesting to surmise as to their exact function in the relationship of the sexes. Perhaps they all have their definite purpose and are not of an "ornamental character" (19). Such questions can be answered only after a careful study of the position these structures take while in the act of copulation. The genitalia of Pentatomidae are situated so that the male and female must face in opposite directions while

copulating. All internal parts are withdrawn into the anterior part of the genital segment and well protected. The external parts, those that have been studied, are not in the majority of cases protected in any way.

SUMMARY

1. The male genitalia of Pentatomidae are so specialized that they give constant specific characters.

2. The female genitalia are of a more generalized type and do not vary enough in all cases to give constant specific characters.

3. In this paper 44 genera, 105 species and 4 varieties of Pentatomidae have been studied.

4. No separation between generic and specific characters has been made where only one species is involved.

5. Definite specific characters are found to exist; no considerable variation was found within the species. In many of the species studied specimens were secured from widely separated localities in the United States.

6. Four definite types of genital segments have been found: Closed Type, Dorsally Open Type, Open Type, and Partially Open Type.

7. The parameres are usually different in different species.

8. The hypandrial ridge is a definite structure in Pentatomidae and varies in such a way that it forms an excellent character for distinguishing species.

LITERATURE CITED

(1) Berlese, A.
1909. Gli Insetti. Societa Editrice Libraria, Milano. V. I, pp. 255-346.

(2) Blatchley, W. S.
1926. Heteroptera or True Bugs of Eastern North America. Nature Publishing Company, Indianapolis, Indiana.

(3) Burmeister, H.
1836. A Manual of Entomology. Trans. by W. E. Shuckard. Edward Churton, London, pp. 108-133; 211-223.

(4) Crampton, G. C.
1922. The Genitalia of the Males of certain Hemiptera (Heteroptera) and Homoptera. Bull. Brooklyn Ent. Soc., 17:46-55.

(5) Distant, W. L.
1902. Rhynchota. Taylor and Francis, London. V. I, p. xxxiii. The Fauna of British India.

(6) Foot, Katharine and Strobell, E. C.
1914. Results of Crossing Euschistus variolarius and E. servus with reference to the Inheritance of an Exclusively Male Character. Jour. Linn. Soc., Zoology, 32:337-373.

(7) 1915. Results of Crossing two Hemipterous Species with reference to the inheritance of two Exclusively Male Characters. Jour. Linn. Soc., Zoology, 32:457-493.

(8) Heidemann, Otto
1904. Remarks on the Genitalia of Podisus cynicus Say and P. bracteatus Fitch. Proc. Ent. Soc., Washington, 6:9-10.

(9) Heymons, K.
1896. Zur Morphologie der Abdominalanhänge bei den Insekten. Morph. Jahrb. 24:178-204.

(10) 1899. Der Morphologische Bau der Insektenabdomens. Zool. Centralbl. 6:537-556.

(11) Jeannel, R.
1921. Sur les segment genitaux des femelles des Pentatomides. (Hemipt.) Bull. Societe D'Histoire Naturelle de Toulouse. 48:43-47.

(12) Kingsbury, B. F. and Johannsen, O. A.
1927. Histological Technique. John Wiley and Sons, New York. p. 74.

(13) Macgillivray, Alex D.
1923. External Insect-Anatomy. Scarab Company, Urbana, Illinois. pp. 210-227.

(14) Newell, Anna Grace
1918. The Morphology of the Genitalia of Insects. Ann. Ent. Soc. Am. 11:109-142.

(15) Parshley, H. M.
1923. The Hemiptera or Sucking Insects of Connecticut. Conn. State Geological and Natural History Survey. Bull. 34:753-776.

(16) Peytoureau, A.
1895. Contribution a l'etude de la morphologie de l'Armure genitale des insects. Paris, Societe d'editions scientifiques. 248 pp., xxii pls.

(17) Ribaut, H.
1913. L'urite IX des males chez les Pentatomides. Bull. de la Societe d'Histoire Naturelle de Toulouse. 40:183-184.

(18) Schröder, C. S.
1925. Handbuch der Entomologie. Gustave Fischer, Jena. p. 112.

(19) Sharp, David
1890. On the structure of the terminal segment in some male Hemiptera. Trans. Ent. Soc., London. 1890. pp. 399-427.

(20) Singh-Pruthi, Hem.
1925. The Morphology of the Male Genitalia in Rhynchota. Trans. Ent. Soc., London. 1925. Pts. I-II:127-267.

(21) Stal, C.
1870. Enumeratio Hemipterorum. P. A. Norstedt & Soner, Stockholm.

(22) Stoner, Dayton
1920. The Scutelleroidea of Iowa. University of Iowa Studies; Studies in Natural History, V. 8, No. 4.

(23) Van Duzee, E. P.
1904. An annotated list of the Pentatomidae recorded from America North of Mexico, with descriptions of some new species. Trans. Am. Ent. Soc. 30: No. 1.

(24) 1917. Catalogue of the Hemiptera of America North of Mexico, Excepting the Aphididae, Coccidae and Aleurodidae. University of California Pub. Ent. V. 2:25-82.

(25) Wheeler, W. M.
1893. A Contribution to Insect Embryology. Jour. of Morph., 8:1-160.

EXPLANATION OF PLATES

All figures of parameres are drawings of the inner aspect of right paramere unless otherwise stated in the written description of the genital segment.

PLATE I

Fig. 1. *Coenus delius* Say, caudal aspect, genital segment in situ, dorsally open type.

Fig. 2. *Neottiglossa sulcifrons* Stal, caudal aspect, genital segment in situ, closed type.

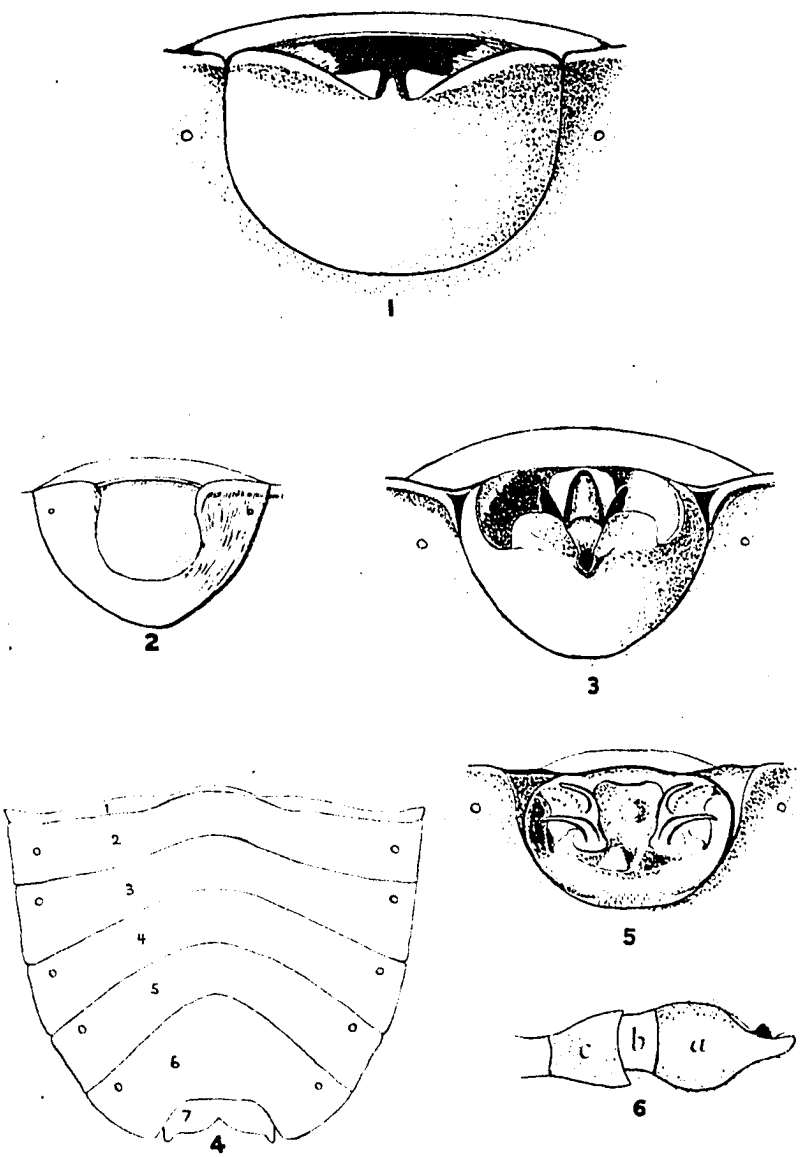
Fig. 3. *Peribalus limbolarius* Stal, caudal aspect, genital segment in situ, partially open type.

Fig. 4. *Peribalus limbolarius* Stal, ventral aspect of abdomen.

Fig. 5. *Apateticus bracteatus* Fitch, caudal aspect, genital segment in situ, open type.

Fig. 6. *Acrosternum hilaris* Say, lateral aspect, genital segment removed from abdomen.

PLATE I



ROSENHALL - GENITALIA OF PENTATOMIDAE

Fig. 21. Peribalus abbreviatus Uhler, Paramere.

Fig. 22. Chlorochroa ligata Say., Paramere.

Fig. 23. Chlorochroa sayi Stal, Paramere.

Fig. 24. Chlorochroa congrua Uhler, Paramere.

Fig. 25. Murgantia histrionica Hahn., Paramere.

Fig. 26. Eysarcoris intergresseus Uhler, Paramere.

Fig. 27. Proxys punctulatus P.B., Paramere.

Fig. 28. Solubea pugnax Fabr., Paramere.

Fig. 29. Thyanta perditor Fabr., Paramere.

Fig. 30. Thyanta custator Fabr., Paramere.

Fig. 31. Thyanta casta Stal, Paramere.

Fig. 32. Thyanta punctiventris Van D., Paramere.

Fig. 33. Thyanta rugulosa Say., Paramere.

Fig. 34. Thyanta antiguensis Westw., Paramere.

PLATE II

Parameres and Pleural Processes

Fig. 7. *Brochymena arborea* Say., Paramere.

Fig. 8. *Brochymena haedula* Stal., Paramere.

Fig. 9. *Brochymena myops* Stal., Paramere.

Fig. 10. *Brochymena affinis* Van D., Paramere.

Fig. 11. *Brochymena tenebrosa* Walk., Paramere.

Fig. 12. *Brochymena carolinensis* Westw., Paramere.

Fig. 13. *Brochymena 4-pustulata* Fabr., Paramere.

Fig. 14. *Trichopepla atricornis* Stal, Paramere.

Fig. 15. *Brochymena cariosa* Stal, Paramere.

Fig. 16. *Peribalus limbolarius* Stal, Pleural Process.

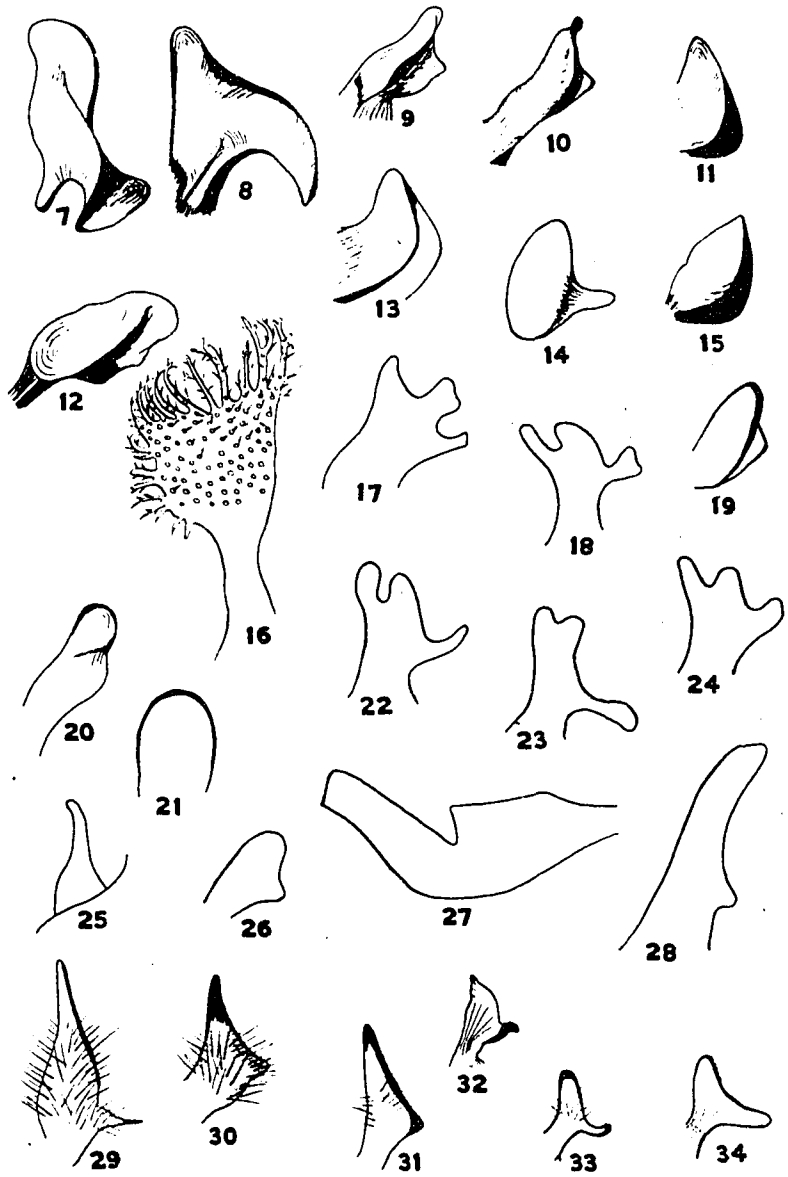
Fig. 17. *Rhytidolomia saucia* Say., Paramere.

Fig. 18. *Chlorochroa uhleri* Stal, Paramere.

Fig. 19. *Trichopepla semivitata* Say., Paramere.

Fig. 20. *Peribalus limbolarius* Stal, Paramere.

PLATE II



ROSEWALL -- GENITALIA OF PENTATOMIDAE

PLATE III

Parameres and Tergites

Fig. 35. Nezara viridula Linn., Paramere.

Fig. 36. Nezara viridula Linn., Paramere, var. torquata Fabr.

Fig. 37. Piezodorus guildinii Westw., Paramere.

Fig. 38. Arvelius albopunctatus DeGeer, Paramere.

Fig. 39. Meadorus lateralis Say., Paramere.

Fig. 40. Stiretrus anchorago Fabr., Paramere, var. violacens Say.

Fig. 41. Perillus bioculatus Fabr., Paramere.

Fig. 42. Perillus exaptus Say., Paramere.

Fig. 43. Elasmostethus cruciatus Say., Paramere.

Fig. 44. Stiretrus anchorago Fabr., Paramere, var. fimbriatus Say.

Fig. 45. Perillus circumcinctus Stal, Paramere.

Fig. 46. Perillus confluens N.S., Paramere.

Fig. 47. Stiretrus anchorago Fabr., Paramere.

Fig. 48. Podisus serieventris Uhler, Paramere.

Fig. 49. Podisus modestus Dallas, Paramere.

Fig. 50. Podisus placidus Uhler, Paramere.

Fig. 51. Podisus sagitta Fabr., Paramere.

Fig. 52. Podisus maculiventris Say., Paramere.

Fig. 53. Podisus fuscescens Dall., Paramere.

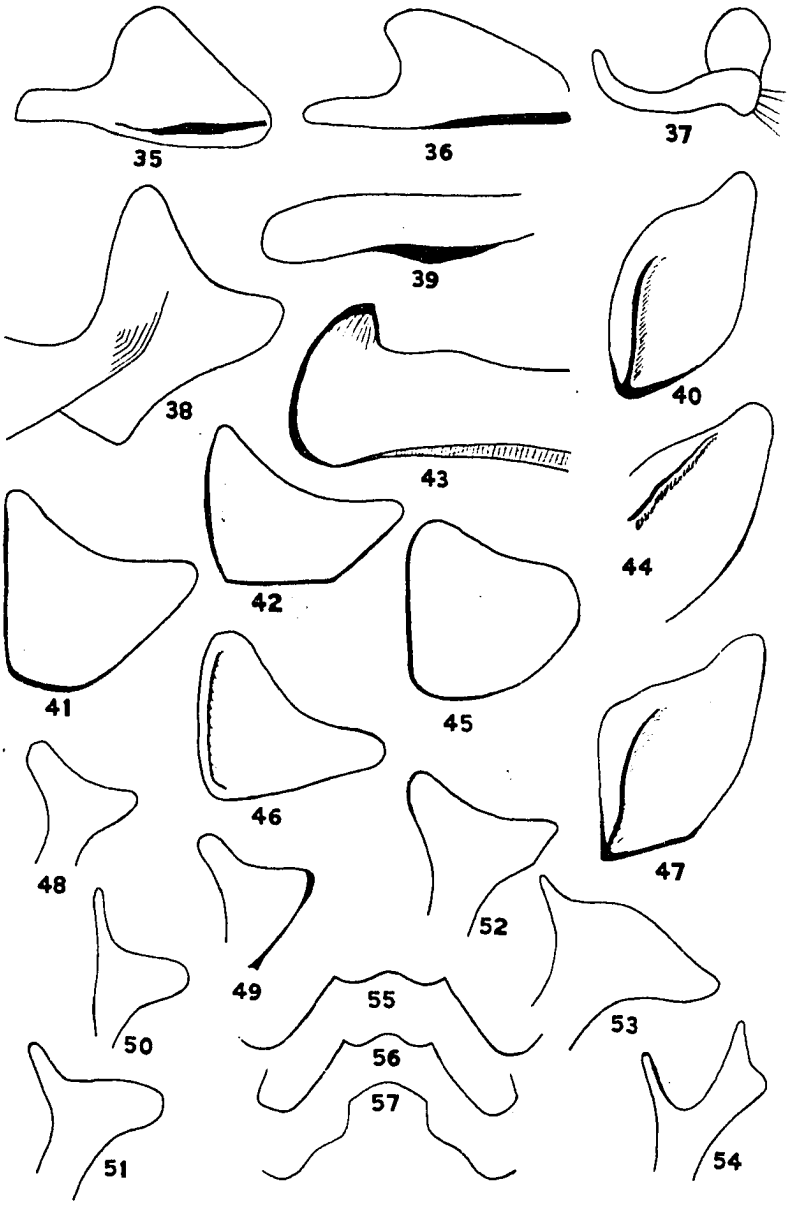
Fig. 54. Podisus mucronatus Uhler, Paramere.

Fig. 55. Apateticus bracteatus Fitch., caudal margin of tergite.

Fig. 56. Apateticus crocatus Uhler, caudal margin of tergite.

Fig. 57. Apateticus cynicus Say., caudal margin of tergite.

PLATE III



ROSENALL - GENITALIA OF PENTATOMIDAE

PLATE IV

Parameres and Hypandria

Fig. 58. Carpocoris remotus Horv., Paramere.

Fig. 59. Zicrona caerulea Linn., Paramere.

Fig. 60. Alcaeorrhynchus phymatophora P.B., Paramere.

Fig. 61. Alcaeorrhynchus grandis Dall., Paramere.

Fig. 62. Cosmopepla decorata Hahn., Paramere.

Fig. 63. Cosmopepla uhleri Montd., Paramere.

Fig. 66. Loxa florida Van D., Paramere.

Fig. 67. Banasa imbuta Walk., Paramere.

Fig. 68. Banasa subrufescens Walk., Paramere.

Fig. 69. Banasa sordida Uhler, Paramere.

Fig. 70. Banasa calva Say., Paramere.

Fig. 71. Banasa packardi Stal, Paramere.

Fig. 72. Dendrocoris fruticicola Bergr., Paramere.

Fig. 73. Dendrocoris humeralis Uhler, Paramere.

Fig. 74. Dendrocoris reticulatus Barb., Paramere.

Fig. 75. Dendrocoris contaminatus Uhler, Paramere.

Fig. 76. Chlorocoris atrispinus Stal, Paramere.

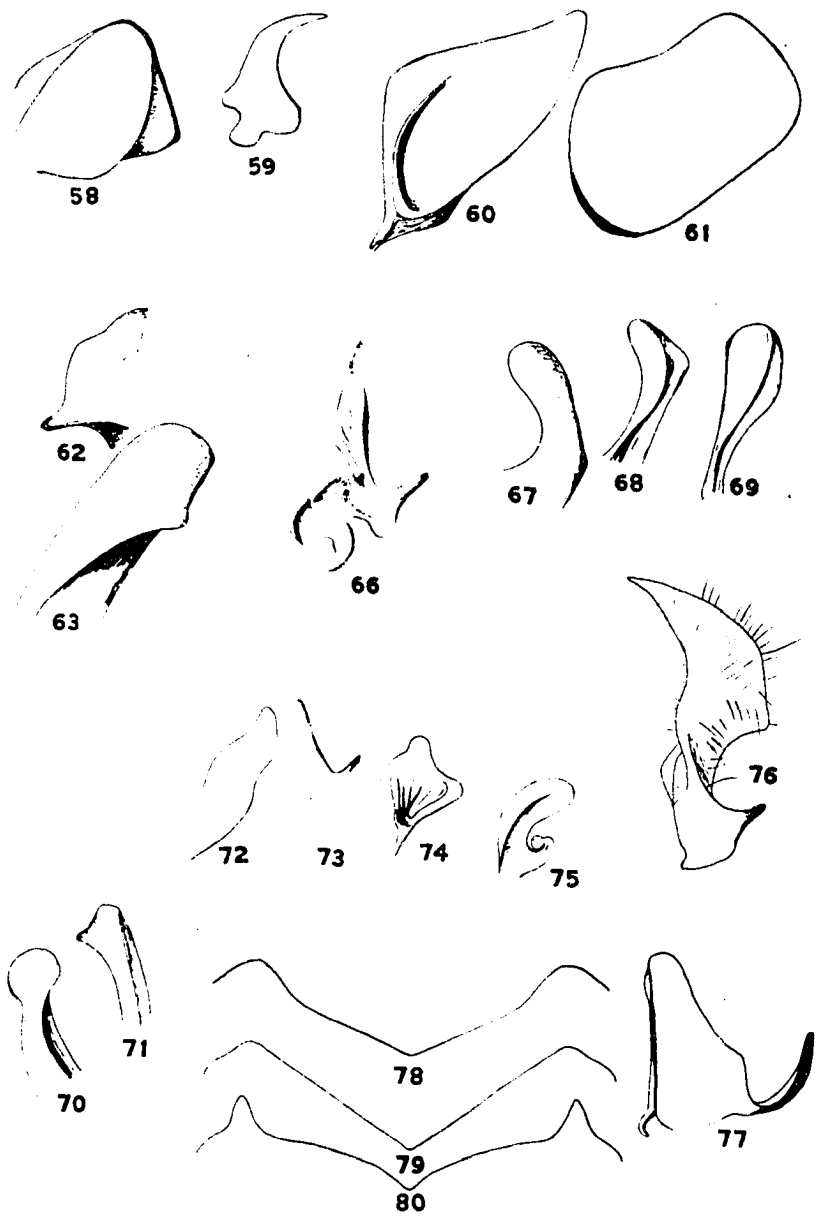
Fig. 77. Aelia americana Dall., Paramere.

Fig. 78. Acrosternum marginatum P.B., ventral view of caudal edge of hypandrium.

Fig. 79. Acrosternum pennsylvanicum De Geer, ventral view of caudal edge of hypandrium.

Fig. 80. Acrosternum hilaris Say., ventral view of caudal edge of hypandrium.

PLATE IV.



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